Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVI. MARCH, 1924 No. 3

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Contracts Awarded

ROADS AND STREETS

Ark., Batesville—Western Construction Co. and R. J. Gaster, Little Rock; also W. I. Davis, Imboden, award. contracts by State Hwy. Dept., Little Rock, for 3 sections of road, each 20 miles long, at total cost of $350,000.

Ark., Blytheville—Rouse Construction Co., Cape Girardeau, Mo., awarded contract for about 10 miles street paving at $409,000.

Ark., Little Rock—Oliver Constr. Co., 322 W. Markham St., Little Rock, awarded contract for completion of Little Rock-Hot Springs Hwy., at about $1,400,000.

Ark., Mammoth Springs—Oliver Constr. Co., Little Rock, Ark., award. contract for 17 miles Sec. C, Mammoth Springs, Batesville Rd. from Salem south, at $100,000.

Ark., Pine Bluff—Philpot Constr. Co., Pine Bluff, awarded contract to pave 2 miles with 2 short laterals, Jefferson Co., Dist. No. 1, 24th Ave. to Cherry St., to Country Club; conc.—at $112,000.

Ariz., Phoenix—El Paso Bitulithic Co. awarded cont. by State Hwy. Dept., for constr. of new Geronimo-Solomonville Hwy., F. A. P. 67, at $230,311. Work includes excav., borrow, gravel cushion, paving (on cem. conc.); struct. conc., steel bridges, etc., etc.

Cal., Burbank—G. A. Simpson, San Fernando Bldg., Los Angeles, awarded contract for improving streets in Ben Mar Hills, including conc. and oil macadam pavement, curbs, gutters and walks here, at $100,000.

Cal., Hawthorne—Geo. R. Curtis, 2440 E. 26th St., Los Angeles, awarded contracts for impvt. of Miramar St., West, at $61,603; involving 1½-in. Willite on 2½-in. asphalt concrete pavement, constructing curbs, walks, gutters; also for impvt. of Miramar St., East (same type of impvt.) at $126,018.

Cal., Los Angeles—Geo. H. Oswald, 366 E. 58th St. awarded contract by Board Pub. Wks., for improving Leesdale St.—Hazeltine Ave. to 100 ft. east of Pacoima Ave.—at $109,826; P. F. Martter, 1250 S. Gramercy Pl. awarded contract for impvt. of Waverly Ave.—Farwell Ave. to 293.8 ft. n. e. from Glendale Blvd., at $10,265; G. A. Constantine, 911 Haas Bldg., contract for impvt. of Sunset Dr.—Myra Ave. to Sunset Blvd.—at $28,764.

Cal., Riverside—R. T. Shea, Riverside, awarded contract for improving portion of Rte. 8, Beaumont to ft. of Moreno Grade, known as Jack Rabbit Trail, at $107,375.

Cal., Sacramento—Geo. H. Oswald, 366 E. 58th St., Los Angeles, awarded contract for constr. of state highway in Los Angeles Co.—Shoup Ave. to west boundary, at $388,785; 13.1 miles to be graded and 11.6 miles to be paved with cement concrete; W .F. Beal, Brawley, contract for constructing state highway Orange Co., bet. Huntington Beach and Corona Del Mar; about 8.2 mi to be graded and 3.5 miles to be paved with cement concrete, at $188,025.

Cal., San Diego—Calif. Construction Co. Union Bldg., awarded contract by Council for improving 25th and Crosby Sts., at $68,919; Cushing Constr. Co. 1501 Brooks Ave., awarded contract for impvt. of State and Goldfinch Sts., also Reynard Way, at $47,898.

Fla., Jacksonville—Following contracts let for road work in Duval County; 19.6 mi. St. Augustine Rd. to J. W. Wilson, Clark Bldg., at $329,000; 14.9 mi. Atlantic Blvd. also Baldwin-Maxwell Rd., to C. F. Lytle, Atlantic Natl. Bank Bldg., at $819,000 and $170,000 respectively; 10.3 miles Kings Rd. to J. Y. Wilson and W. J. Bryson, 1418 W. Church St., at $189,000; 11 miles Main Street Rd., 5.5 miles Moncrief Rd. and 5.4 miles San Jose Blvd., to W. J. Bryson, 1418 W. Church St., at $203,000, $96,000 and $79,000; 6.3 miles Orange Park Rd. to W. J. Bryson and T. B. Gillespie, Palatka, at $93,000.

Ga., Atlanta—Following contracts let by State Hwy. Dept.: Columbia Co., 6.148 miles sand-clay rd. and 3 creo. timber bridges on Appling-Lincolnton rd., to Oglesby & Starke, Elberton at $37,377; Stephens-Habersham Cos., 1.41 mi. clay-gravel on Toccoa Cornelia Rd. to Burgess & Mozeley, Toccoa, at $17,275; Lumpkin Co., 3 mi. waterbound macadam on Dahlonega-Dawson Rd. to T. P. Wright, Atlanta, at $20,900; Lowndes Co., 10,537 mt. gravel rd. and bridge on Valdosta-Adel Rd., to J. L. Wallace, Norman Park, at $159,580.

Ind., Indianapolis—McNamara Construction Co., Indianapolis, awarded constract by City Park Board for paving Kessler Blvd.—Meridian Street west to Cooper Ave. and south to Crawfordsville road, at approx. $512,000. Road will be paved with bitum. macadam.

Iowa, Dubuque—J. Rasmussen Sons Co., Oshkosh, Wis., awarded contract for sheet asphalt paving at $240,000; Ulrich Paley Co., Dubuque, hard top pavements, at $220,000 for paving 41 miles.

Ia., Iowa Falls—Dearborn Paving Co., Waterloo, awarded contr. for Twp. Proj., 25,850 ft. curb and gutter, 76 cents per ft., pav. 6 in. vibrolithic, $2.24 per yd.; total cost, $108,396. City Primary Rd. Proj., 19,270 sq. yds. 8 in. reinf. vibrolithic, $2.58 per yd.; 9,375 lin. ft. curb and gutter, 78 cents; 4,000 c. y. extra excav. 60 cents per c. y. ; 100 c. y. rock excav., $3.50 per yd.; old walk, impvts., 4 cents per ft.; new walk, 9 cents per ft.; 18 in. storm sewer, $2.25 per ft.; 12 in. at $1.25; catch basins $27 each, $35 with trap; manholes, $35 each, total cost, $59,779.

Iowa, Moulton—Wright Bros. Constr. Co., 211 Flynn Blk. Des Moines, awarded contract for 28 blocks 7 in. rein. conc. paving, at about $91,500.

Iowa, New Hampton—Bryant Asphalt Paving Corp., Waterloo, awarded contract for 34,000 sq. yds. paving, at $95,000.

Kans., Topeka—Stimson Constr. Co., Topeka, awarded contract for conc. pavement; F. A. P. 177, Sec A, at $127,762

Ky., Frankfort—State Hwy. Dept., let contract for waterbound macadam paving on 15.133 mi. Owenton-Georgetown Rd., 14 ft. State Proj. 49, Sec. A, Scott Co., to Georgetown Constr. Co., Georgetown, at $293,206; rein. conc. pavement on 3,747 mi. Louisville-Bardstown Rd. 20 ft. F. A. P. 50, Sec. B, Jefferson Co., to Louis de Cognets Co., 413 E. Main St., Lexington, at $191,209; grading 3.167 mi. Harlin-Pineville Rd. 24 and 28 ft. State Proj. 6, Sec. C, Harlan Co., to J. S. Lusk Co., Barboursville, at $33,603.

La., Baton Rouge—City let contracts for paving 15 streets as follows: Southern Rds. Co., Dufroc St.—Main to Government, at $24,348; Elam—Boyd to North—at $5,323; East Blvd.—Government to at $9,356; Florida, $52,362; Laurel, $57,512; St. Anthony, $9,358; St. Ferdinand St., $13,074; St. Hypolite, $2,382; St. Joseph, $2,365; University Walk, $4,491; all Warrenite-bitulithic; Valient & Tooney, Inc., contr. for Bonnecaze St., $16,780, Convention St., at $16,659; No. Blvd., $31, 248.

La., New Orleans—Comn. Council has awarded following contracts at cost of $1,000,000: Subsurface, draining and surfacing. A. P. Boh & Co., Grasser Constr. Co., Williams Engrg. Co., Mike Mitchell and Sons, Jno. O. Chisholm, H. W. Bond & Bros., Hampton Reynolds contracts for sub-drainage; Craven & Long and Globe Construction Co., paving contracts.

Minn., Hibbing—E. W. Coons Constr. Co., 4th Ave. at Howard St., awarded contract for paving 25 streets in So. Hibbing and Brooklyn; vibrolithic surf., at $190,000.

Miss., Leland—R. G. Lassiter, 327 Arcade Bldg., Norfolk, Va., awarded contract for paving 70,000 sq. yds. various streets; 1½-in. Willite top, 1-in. binder on 5-in. concrete, at $2.49 per sq. yd.

Nev., Carson City—State Hwy. Comn. let following contracts: Improving 17.59 mi.—Mormon Mesa to Nevada-Arizona State line, Rte. 6, Sec. H., Clark County; 222,000 c. y. excav., 11,200 c. y. loading and screening, 29,400 yds. mi. hauling and 11,200 c. y. spreading gravel, 190 cu. yds. Cl. A and 220 c. y. Cl. B conc., etc. to Dodge Bros. & Dudley, Fallon, at $217,536.

Nev., Carson City—K. Hodgman, Winnemucca, awarded contract by State Hwy. Comn., for impvt. of 5.03 miles bet. Carroll Summit and Campbell Creek Ranch, Proj. 56-B, Lander 2-A, Contr. 96, at $58,200 cu. yd. excav., 1,900 c. y. load and screen selected material, 155 c. y. Cl. A conc., 2,350 c. y. riprap, etc., at $103,948.

N. Y., Albany—L. Grossman, Commr. State Hwy. Dept. Albany, let contracts for constr. and re-construction of 4.75 mi. Repair Contr. 3077, Oswego Co., to Brayer Bros., North St. Rd., Auburn, at

$101,848; 1.18 mi. Repair Contr. 3076, Allegany Co. to W. J. Fox, Oramel, at $79,097; 1.19 mi. Repair Contr. 3075, Dutchess Co., to Mascetti and Holley, 60 Main St., Torrington, Conn., at $67,240; 3.82 mi. Hwy. 8166,O range Co., to Gould, Granz & Mandel, 101 Reade St., New York City, at $167,636; 5.3 mi. Hwy. 5697, Orleans Co., to J. M. Murray, Rochester, at $184,009; 4.85 mi. Hwy. 8165, Madison Co., to G. B. Dickinson, Union Bldg., Syracuse, at $187,452; 4.34 mi. Hwy. 8164, Wyoming Co. to C. A. Foote & Sons, Mt. Morris, at $199,733; 8.79 mi. Hwy. 8156, Ontario Co., to Valerio Constr. Co., New Milford, Ct., at $287,243.

N. C., Fayetteville—Alabama Concrete Products Co., Selma, Ala., awarded contract for 6 mi. 18-ft. conc. road from Fayetteville to Ft. Bragg—at $225,000.

N. C., Raleigh—Alabama Concrete Products Co., Selma, Ala., awarded contract for grading and plain conc. paving on 5.52 miles State Proj. 344, at $158,257.

N. C., Raleigh—State Hwy. Comn., let contracts for 16 road projects as follows: No. 106-B, Bertie Co., 11.56 mi. to R. G. Lassiter, Raleigh, at $151,721; 111-Camden Co. for brdgs. to W. B. Bradley, at $12,396; 222-Duplin Co., 10.01 mi. roadway bet. Warsaw and Pender Co. line to Highway Engrg. & Constr. Co., at$ 242,085; and to Hobbs-Des Moines Steel Co., at $16,117 for structs.; 381-Pender Co., 11.09 mi. bet. Burgaw and Duplin Co. line, to Public Service Productions Co., at $372,798; 449-A, Lee Co. 2.51 mi. gravel roadway bet. Pittsboro and Sanford to Austin & Ritchie, Ritchfield, at $21,363 and to C. D. Rigsbee, Durham, at $5,020 for structures; 472-B, Vance Co., 4.66 mi. grading to T. W. Chandler, Virgilina, Va. at $37,449 and to J. A. Harrow, Soudan, Va., at $38,973 for structs.; 622-Richmond Co. grade and constr. brdgs. on 6.19 mi. to T. W. Chandler, at $41,606 and to Yadkin Constr. Co., at $24,573 for structs.; 714-Ashe Co., grading and bridges on 5.34 mi. bet. Jefferson and Watauga Co. line to J. F. Mulligan, at $98,762; Boose & Boyd, at $23,647 for structs. 720-Caldwell Co., 12.52 mi. pavement bet. Lenoir and Hickory to J. M. Gregory & Co., Newton, N. C., at $453,527 and to Berry Fortune Constr. Co., at $36,295 for structs.; 732-B Davie Co. 8.07 mi. paving to Hardaway Constr. Co., Charlotte, at $282,758; 836-Henderson Co., 9.51 mi. paving to J. M. Gregory & Co., at $280,580; 912, Cherokee Co., 8.62 mi. grading to Wilson Constr. Co. Rutherfordton, at $81,006; 912-B Cherokee Co., 8.35 mi. grading to H. T. Moore, at $32,981; 990-Transylvania, .47 miles waterbound macadam to Piedmont Constr. Co., at $12,238; 992, Transylvania Co., 1.57 mi. waterbound macad. to W. H. Anderson Constr. Co., Spruce Pine, at $45,432 and to R. C. Stevens, at $16,178 for structures.

Okla., Okla. City—M. A. Swatek Co. awarded contract at $59,000 to pave with vert. fibre brick on 5-in. concrete base, 2 miles East G Ave.; Green-Beekman Construction Co., at $92,111 to pave with vert. fibre brick on 5-in. concrete base, 2½ mi. Eastern Ave.—10th to Lincoln Park.

Okla., Tulsa—City let contracts at $168,470.86 for street paving in following districts: Western Construction Co., Dists. Nos. 512-514-5-16-321-A; C. M. Brown, Dist. 517; H. L. Cannaday Co., Dist. 515-519.

Tenn., Nashville—State Hwy. Dept. let contract to grade and construct drainage structs. on 8 road projects as follows: F. A. Projs. Nos. 95 and 97, Sullivan Co., grade, 14.41 miles conc. bet. Blountsville and Kingsport, including 2 brdgs. to Dickson Contracting Co., Savannah, Ga., at $583,-186; No. 100, Haywood Co., 16.07 mi. betw. Blountsville and Tipton Co. line to Little & Dean, Memphis at $106,700; State Aid Proj. 116, Perry Co., 13.49 mi. bet. Linden and Lewis Co., line to C & G Constr. Co., Hohenwald, at $82,659; 130, Cumberland Co., 15.56 mi. betw. Crossville and White Co. line, including 3 bridges to A. M. Cook, Oneida, at $168,189; 139, Montgomery Co., .63 mi. bet. Cumberland River brdg. and City ferry rd., to Federal Constr. Co., Nashville at $15,636; 150, Coffee Co., 7.60 mi. cement conc. bet. Manchester and Hillsboro, including 2 bridges, to Citizens Engrg. & Constr. Co., Savannah, Ga., at $114,105; 153, Greene Co., 2.25 miles waterbound macadam surf. 10-ft. wide, including channeling shoulders and ditching bet. point no. of Nolichuck Ricer and point near Caney Branch, to Anderson and Scott, Harriman, at $14,257.50.

Tenn., Sparta—Boyd Williams, Murfreesboro, Tenn. awarded contract to grade, construct drainage structs. and lay coarse stone base with bitum. macadam surf. on 13.64 mi. road bet. Sparta and Warren Co. line, including rein. conc. bridge, at $376,971.

Texas, Dallas—City let contracts to pave 57 streets as follows: Fuller Construction Co., at $163,320 for 41,152 sq. yds. Willite asph. conc. paving on 7 streets; Uvalde Paving Co., at $135,729 for 35,720 yds. Uvalde rock asphalt on 7 streets; Smith Bros. at $656,808 for 178,285 yds. Willite asphalt conc. on 31 streets; Central Bitulithic Co. at $279,339 for 71,990 wds. Warrenite bitulithic on 12 streets—all of Dallas.

Texas, Hallettsville—L. E. Sanders, San Antonio, awarded contract for bridge and road work on 14 miles State Hwy. No. 3-B from Hallettsville to Fayette Co. line, at $124,964.

Texas, Nacogdoches — Panhandle Construction Co., Lubbock, Texas, awarded contract to lay 5-in. concrete and 3-inch fibre brick on 7,500 sq. yds. streets, at $225,000.

Wash., Olympia — A. P. Knutzen, Lynden, awarded contract for clearing 60-ft. right-of-way on the Olympia Hwy.,—Lunch Creek, Grays Harbor Co. westerly 10.98 miles to bound. of Quinault Indian reservation—73.6 acres, at $34,227; C. A. Strong, Tacoma, awarded contract for 22.36 miles clearing on Olympic Hwy.—Hoh river southward to no. boundary of Quinault reservation, at $146,869 (164.1 acres).

Wyo., Cheyenne—Taggart Constr. Co., Cowley, awarded contract by State Hwy. Comnrs., Cheyenne, for improving 5 miles 20 and 24 ft. Cody-Yellowstone Park Rd., Park Co., FAP 129, including grading, excavating, embankment, retaining walls, cast iron culverts etc., at $165,853, including engrg. and overhead (culverts furnished by State): 1.3 miles Cody-Yellowstone Hwy., Part 3, to M. J. Kinney, 215 Bank Bldg., Denver Colo., at $15,560.

SEWERAGE AND SEWAGE TREATMENT

Ark., Ft. Smith—Benson & Farrar, Ft. Smith, awarded contract for san. sewers in Impvt. Dist., 4, at $36,438.

Cal., Long Beach—Geo. W. Kemper, Alhambra, awarded contract for constr. of Santa Fe Ave. storm drain, including Termino, Roswell and other streets, at $83,000.

Cal., Newport Beach—Gibbons-Reed, 905 S. Olive St., Los Angeles, awarded contract for Balboa Is'and sewerage system, at $133,655.

Cal., Orange—C. E. Green, Western Mutual Bldg., Los Angeles, awarded contract for constr. of 2 sections of outfall sewer at $41,982 and $19,944.

Ont., Toronto—City has awarded following sewer contracts: St. Clair Ave. E., $5,927, Douglas Dr., $2,279, W. E. Taylor, 22 Falcon St.; Pleasant Blvd., $9,058, A. Cavotti; 257 Euclid Ave.; Lansdowne Ave.; $22,433, Tyrell Ave., $34,983, W. R. Worthington, 57 Lascelles Blvd.; Garden Ave., $2,170, Heath St., $5,471, P. Licastro & Co., 1423 Dufferin St.; Broadview Ave., $3,365 and St. Clair Ave., W., $3,972, Murphy Contracting Co. 8 Wychwood.

Ill., Mt. Morris—Craig Constr. Co., Des Moines, Iowa, awarded contract for 10,000 ft. san. sewers and 2 disposal plants, at $56,000.

La., Baton Rouge—Com. Council let contract for storm drains in Goose Hollow Canal to R. J. Estep, Gravel Deere Bldg., Dallas, Texas, at $63,524; St. Philip St. Canal and Roseland Terrace Canal to C. B. Stewart, Baton Rouge, at $41,064 and $14,200, respectively.

La., Baton Rouge—J. B. McCrary Co., Atlanta, Ga., awarded contract to construct S. Boulevard sewer main, at $51,091.

Mass., Boston—A. Cefalo, Belgrave Ave., Roslindale (Boston, P. O. for 3,476 ft. 20 and 30-in. earthen pipe sewer, at $59,608.

Mich., Royal Oak—Liberty Constr. Co., Detroit Savings Bank Bldg., Detroit, awarded contract for san. main sewer in Campbell Rd., 14,115 ft. 12-30 in. conc. pipe, at $97,362.

Minn., Hibbing — Schirmer Bros. Hibbing, awarded contract for additions to san. sewers in So. Hibbing, at $50,707.

Minn., St. Paul—Outlet sewer in Portland Ave., to DeGraff Wolff, 985 Scheffer St., at $25,780;

Davern- W. 7th St. sys. No. 1, to Thornton Bros. Co., 318 Endicott Bldg., at $206,587.

Mo., Carrollton—T. M. Walsh, 2953 Victor St., Kansas City, awarded contract for 34,000 ft. 8-21 inch vit. sewers, etc., at $37,608.

Mo., St. Louis—Bd. Pub. Service, 208 City Hall, let following contracts for sewer work: 505 ft. 10-12-in. vit. clay sewer, Clifton Heights Sewer 4, to Riley Bros. Constr. Co., International Life Bldg. at $2,251; 6,505 ft. 8-27 in. vit. clay and 1,725 ft. 36, 66 in. conc. sewer in Glaise Crk. Sewer 19, also 2,100 ft. 12-24 in. vit. clay sewer in Glaise Crk. Dist. Sewer 24, to Hogan Contg. Co., 2,120 Harris Ave. at $47,025 and $7,790, respectively: 1,065 ft. 8-21 in. vit. clay sewer in Glaise Creek Dist. Sewer 23, to Higgins-Wall-Dyer Constr. Co., International Life Bldg., at $3,725.

Mo., University—(St. Louis, P. O.) For 2,400 ft. vit. clay and segmental blk. sewer in Colby Ave., also 2,650 ft. 12-36 in. vit. clay and 575 ft. 42-in. segmental blk. sewer in N. Penn. Ave., to Stollemoll Construction Co., 5243 Delmar Blvd., St. Louis, $20,921 and $20,706 respect.; 3,161 ft. 12-36 in. sewer in River Des Peres Sec. A12, 797 lin. ft. 10-in. to 12-in. vit. clay sewer in Dist Sewer 29, also 4,475 lin. ft. 10-24 in. vit. clay sewer in Dist. Sewer 26, to A. Lewald, 1219 Amherst Pl. St. Louis, at $26,147, $1,703 and $9,673, respectively.

N. Y., Brooklyn—B. Peconi & Sons, awarded contract for sewers in 24th Ave. and E. 36th St., at $37,586 and $2,245, respectively.

N. Y., Long Isl. City—Contract for sewers across Queens Blvd., intersect. various streets, to F. L. Paino, 572 First St., Brooklyn, at $224,543; Patterson Ave to Necaro Co., Inc., 97 Court St., Brooklyn, at $756,404; Astoria Ave., to J. Gallo, 203 Division St., Brooklyn, at $19,800.

Ohio, Cleveland—Gantose Constr. Co., Columbia Bldg., awarded contract by Cuyahoga Co., for 17,000 ft. 8-60 inch vit. or rein. conc., also 8,000 ft. 30 to 60 inch brick or concrete sewer in State Rd. (Impvt. 10) at $297,767.

Ohio, Mariemont—Cannel-Conrad Constr. Co., Madison Rd., Cincinnati, awarded contract by Mariemont Company for 3,000 ft. 18 and 20 inch vit. pipe, connect. to Cincinnati sewerage system; also small tunnel under tracks of Norfolk & Western R. R., etc., at $34,717.

Ohio, Toledo—C. W. Hanneman, Monroe, Mich., awarded contract for Honnem (- s4niv.l326u0 TH awarded contract for Homeville Co.,—18,720 c. y. excav. 1762 ft. 7 ft. 6-in. rein. conc. box culvert and 350 ft. 42-in. segmental blk. pipe in Ditch 561, at $57,243.

Okla., Chickasha—Gibson & Mitchell Constr. Co., Pauls Valley, Okla. awarded contract to construct sewerage impvts.—disposal plant and outfall sewer at $43,500.

Okla., Stroud—H. L. Cannaday Co., Tulsa, awarded contract for main san. sewers, disposal plant and lateral sewers, at $94,622.

Tenn., McKenzie—Sherman Machine & Iron Works, 18-32 E. Main St., Okla., City Okla., awarded general contr. for sewerage system, at $59,200.

Tex., Big Springs—Roy Irick, Plainview, Texas, awarded contract for installing sewer system, including disposal plant. Constr. cost $42,000.

Tex., Dallas—T. S. Miller, Jr., 800 N. Crawford St., awarded contract for conc. and vit. mains and laterals in Frederica, Henderson and Lewis Sts., at $50,174; storm sewers in E. Grand Ave., to Municipal Excav. Co., 800 N. Crawford St. at $31,970.

Texas, Dallas—W. G. Cullum, awarded contract for constr. of sewer lines in Stephenson Addn., at $30,000.

Tex., Kerrville—Wilder Constr. Co., 235 Moore Bldg. awarded contract for construction of sewer and disposal plant, at $70,237.

WATER SUPPLY AND PURIFICATION

Que., Beauport—J. A. Auclair, Giffard, Que., awarded contract for excavating trench and installing cast iron pipe from source to village, 3 miles, in connection with $200,000 water works system. Contract price $35,000. Bids will also be called in about a month for installing water works system in village. Edouard Hamel & Cie, Que., Que., Engrs.

Ont., Goderich—Federal Construction Co., Ltd., 217 Bay Street, Toronto, awarded general contract for intake plant to be built here, at $57,750.

N. S., Sydney Mines—Canada Iron Foundries, Ltd., Three Rivers, Que., awarded contract to supply 670 tons pipe for water main and pumps being installed here. Total cost main and pumps, $100,000.

Cal., Glendale—Kinne & Westerhouse, I. W. Hellman Bldg., Los Angeles, awarded contract by City for 15 m. g. reservoir; at $78,650;—excav.; $61,650 lining and excav. and $16,540 for roofing.

Cal., Pasadena—Pacific Pipe and Supply Co., awarded contract for furnishing assorted pipe for use in Pasadena municipal water dept., at $173,806. Bid was for Port-a-Mousson pipe per City of Paris, France, specifications. Bids for fittings rejected: purchase of these to be made separately.

Cal., San Francisco—Westinghouse Electric & Mfg. Co., Union Bank Bldg., Pittsburgh, Pa., awarded contract for elec. transmission line insulators for Hetch Hetchy power and water supply, at $90,000.

Ill., River Grove—J. M. Donahue, Stevens Point, Wis., awarded contract for laying several miles four and six inch mains, at $160,568.

Ky., Elizabethtown—Mason Contracting Co. West Point, awarded contract for filtration plant, 2 units, 1 m. g. capy., at $39,000.

La., Gibsland—McIntosh Construction Co., Monroe, La., awarded contract for constr. of water works, at $39,466.

Mo., Cameron—W. S. Barnes Agency, Kansas City, awarded contract for two 300 hp. and one 20 hp. oil engines and generators, two 24,000 gals. storage tanks, 2 switchboard panels, cooling system and pumps; also brick bldg. to house equipment, at $62,000.

Mo., Kansas City—U. S. Cast Iron Pipe and Foundry Co., Burlington, N. J. and National Cast Iron Pipe Co., Birmingham, Ala., for 6,234 tons of pipe at $356,000.

Mont., Kalispell—U. S. Cast Iron Pipe and Fdry. Co., 122 S. Michigan Ave., Chicago, awarded contract for material for water main renewal in Railroad St.—4th Ave. E. to 8th Ave. W.— at about $40,000 for 545 tons cast iron pipe.

N. C., Laurinburg—Tucker & Laxton, Realty Bldg, Charlotte, awarded contract for pumping station, filtering plant, reservoir, auxiliary station, laying pipe line, furnishing pumps, etc., at $100,000.

N. C., Wilkesboro—W. A. Ebert, Charlotte, N. C. awarded contract for constr. of water supply system, at $40,000.

Ohio, Cincinnati—U. S. Cast Iron Pipe and Foundry Co., Addyston awarded contract for 4, 6, 8 and 10 inch cast iron pipe and special castings at $55,000.

Ohio, Cincinnati—U. S. Cast Iron Pipe & Fdry. Co., Addyston, awarded contract for approx. 10,000 ft. 10 and 16 inch cast iron pipe, at $94,166.

Penn., Shamokin—Gannett, Seelye & Fleming, 204 Locust St., Harrisburg, awarded contract for addition to No. 6 reservoir, increasing capy. from 600 m. g. to 1,400,000,000 gals., also 5 m. g. rein. conc. reservoir, at $300,000.

S. C., Spartanburg—American Cast Iron Pipe Co., Birmingham, Ala., awarded contract for 6,800 ft. 20-in. water main and 6,000 ft. 6-in. pipe, at $42,360.

S. D., Milbank—Phelps-Drake Co., 623 Metropolitan Life Bldg., Minneapolis, Minn., awarded contract for furnishing and laying 47,600 lin. ft. 8 and 10 inch cast iron mains, at $94,018; repairing elevated steel tank to Chicago Bridge and Iron Works, 608 S. Dearborn St., Chicago, Ill., at $2,275.

Wash., Seattle—Jahn & Bressi, awarded contract for constr. of Lake Youngs reservoir project, at $1,210,000.

W. Va., Fairmont—Rust Engineering Co., Pittsburgh, Pa., awarded contract at $124,473 for constr. of water filtration plant at $124,473; Robert Filter Mfg. Corp., Philadelphia, Pa., awarded contract for filtration equipts.

Wis., Athens—U. S. Cast Iron Co., 122 S. Michigan Ave., Chicago, awarded contract for cast iron water pipe—16,457 ft. 6 in., 1,935 ft. 8 in., $59 per ton, 13,600 lbs. specials, $120 per ton; valves to Darling Valve Co., Williamsport, Pa., 20 6 in., $25, three 8 in. $40; hydrants to Waterous Fire Engine Co., 80 Filmore Ave., E., St. Paul, Minn., 23 hydrants at $57 ea.

Prospective Work

ROADS AND STREETS

Ala., Florence—City plans 5 miles street paving and 3 miles storm and san. sewers. Approx. cost $300,000. W. M. Paxton, Engr.; W. S. Eastep, Mayor.

Ark., Little Rock—City plans to pave Summitt St.—17th to Wright; 18th—Battery to Schiller; Wolfe—7th to Wright. Total est. cost $93,000.

Ariz., Phoenix—$285,948 appropriated for forest highways in State during 1924. E. S. Wheeler, Dist. Engr. Bureau of Public Roads. State Hwy. Dept. has est. cost of proposed highway work for this year at $3,900,000. Bureau of Public Rds. has appropriated $285,948 for roads in Ariz. as follows: $65,000 for expense in Clifton-Springerville hwy., Greenlee Co. or contingencies of constr. impossible to estimate in original cost figures; $81,000 for additional cost of Prescott-White Spar Rd., this to be used in addition to last year's appropriation for constr. of 16-mi. stretch; $8,000 for addition, cost on Clifton-Springerville Rd., Apache Co.; $81,720 for grading Flagstaff Angell Rd., running 26 miles east from Flagstaff; $50,000, remainder of total funds available, to be used in surfacing as far as funds will go, Flagstaff-Angell Rd.

Cal., Santa Ana—Local property owners at Costa Mesa have organized to petition County Supvrs. to pave Fairview Ave., Santa Ana Street and Newport Ave. Est. cost $137,000. Proposed work involves about 5 miles of pavement. J. L. McBride, Co. Rd. Commr.

Fla., Miami—City will soon receive bids to pave various streets in southwestern and northwestern sections, including S. W. 4th, 5th, 2nd and 7th Streets—12th to 17th Aves.; S. W. 13th—8th to 13th; S. W. 14th, 17th, 13th Aves.—Flagler to 8th Sts., etc. Est. cost of improvement, $397,662. F. H. Wharton, City Mgr.

Fla., Sarasota—Sarasota County plans to construct 2 roads; $590,000 bonds voted as follows: Rd. sys. on mainland, $500,000; road down the keys and 2 bridges across Saratosa Bay from Mainland to Key, $90,000.

Fla., Tampa—State Rd. Dept., Tallahassee, appropriated $100,000 to widen about 12 miles Riverview rd. section of State Rd. No. 5.

Fla., Tavares—Lake County contemplates bldg. 2 roads as follows: Complete Eustis-Tavares lake shore drive bordering Lake Eustis; lake shore boulevard around no. side Lake Minneola. $105,000 bonds sold.

Fla., Wauchula—$870,000 available for road building in Hardee County. Geo. R. Ralph, Engr.

Georgia, Atlanta—City will soon receive bids for paving 24 sts. including Atlanta, Cherokee, Highland, May Aves., Beecher, Baker, Broad, Crew, Cain, Gaston, Hall, Houston, Jackson Sts. Est. cost $380,573.

Ga., Atlanta—City and Fulton Co. plan to repave Broad St. from Luckie to Mitchell. Approx. cost $80,000. Walter A. Sims, Mayor.

Ga., Macon—Election may be held April 14th to vote on $600,000 bonds for following impvts.: Pave streets and repair defective pavements at cost of $100,000; build bridge across Ocmulgee River, $150,000; build or extend surf. or storm and san. sewers, $225,000; build fire engine house and purchase and repair fire equipt., $25,000; build athletic stadium, $100,000. Luther Williams, Mayor.

Iowa, Boone—Will pave 74 additional blocks here. Otto Hile, City Clk.

Ia., Davenport—Scott Co. will probably hold election in April tov ote on $1,250,000 bonds for hard surfacing abt. 30 miles Princeton hwy., Blue Grass River Rds.; also Division St. Rd. Est. cost pav. $900,000, gradg. $135,000, etc., etc.

Ia., Knoxville—Plans being made for about 60 blocks municipal pavement on cost plan. W. E. Rinehart, City Clk.

Ia., Marshalltown—Resolution passed for paving various streets; 105,000 sq. yds. plain conc., rein. conc. vibrolithic or reinf. vibrolithic. Also resurface pavement on E. Church St.—S. 3rd Ave. to S. 4th Ave., 30 ft wide. City Engr. O. G. Heim; Anne McMahon, City Clk.

Iowa, Perry—City contemplates paving 25 blocks in Dist. 1 to 7; concrete, vibrolithic conc., vit. brick, asph. conc., sheet asph. bitulithic or asph. conc. Also to resurface streets with sheet asphalt or asbestosphalt. R. C. Lutze, City Engr, C. E. Roblett, City Clk. Est. cost $100,000.

Ky., Fulton—Fulton County plans to build hard surfaced rds. and bridges in County. $450,000 bonds voted.

La., De Ridder—Beauregard Parish, Ward Seven, plans to construct 2 roads totaling 29 miles as follows: From end of present gravel rd. at line betwn. Wards 3 & 7 via Sugartown to Parish line nr. Pitkin, connecting present rd. via Elizabeth to Oakdale; Broadlands to Allen Parish, via Dry Creek connecting with rd. to be built from Oberlin.

Md., Baltimore—State Roads Comn., 601 Garrett Bldg., plans to complete 31½ miles Crain Hwy. in Southern Maryland. Est. cost $1,250,000.

Md., Baltimore—City plans to pave, repave and resurface about 19 streets.

Minn., Austin—Mower County will improve 51½ miles of hwy. this year. C. M. Hubbard, Co. Aud.

Minn., Minneapolis—Following work is to be done in Hennepin Co., during 1924: Minnetonka Blvd.,—Farwell Ave. to City limits. Abt. 2 miles, Est. cost $80,000; Bush Lake Rd.—Jefferson Hwy. w., grade 5 miles. Est. cost $25,000; Bush Lake Rd., bet. Chaill-Ft. Snelling-Shakopee Rd., grade 5 mi. Est. $30,000; Eden Prairie Rd.—Hankins Cor. to Co. line near Shakopee; grading $40,000; Dayton-Shakopee Rd. bet. Rockford and Bass Lake Rd. Grade; $20,000. Jno. W. Shaffer, Co. Surveyor, 410 Court House; Al. P. Erickson, Aud.

Minn., Rochester—$130,000 bond issued voted for constr. of Lake City Rd.——Rochester to Olmsted Co. line north. Amiel L. Glabe, Co. Aud.

Mo., St. Louis—Bd. Pub. Service, 208 City Hall, had prelim. plans prepared and will take bids in Spring for grading 2,085 c. y. Devlin Ave., $4,200; grading, conc. curbing and paving 2,615 sq. yds. Magnolia Ave., Kentucky rock asph., $13,000; 6,350 sq. yds. Margaretta and Plateau Sts., Warrenite, $35,350; 2,370 sq. yds. Oleathe St., rein. conc., $12,250; 2,900 sq. yds. Sulpher Ave., asphalt, $19,250. W. W. Horner, Engr., City Hall.

Mont., Billings—Dept of Agriculture, branch of forest service, allotted $100,000 to build road in Glacier Natl. Pk., bet. Belton and Java. W. D. Fisher, Secy. of Custer Battlefield Hwy. Assn.

Mont., Missoula—More than 45 miles forest highways will be constructed in this State and northern Idaho during 1924, according to report of Frank Andrews, Senior Engineer of Bureau of Pub. Roads. Cost of hwy. constr., will be approx. $620,000, of which $545,000 is provided for Fed. Govt. All these roads are new contracts and do not apply to projects which are now under construction but not completed.

Neb., Omaha—Ready for bids for paving 2¼ miles on Lincoln Hwy. Tentative plans for paving 18 miles state roads, including laying brick on base built in 1923 on 4 mile hwy. out of Fairacres; paving road No. 52 abt. 4 mi. connecting Lincoln and Military highways; 1 mile on 16th St.; abt. 4 mi. on Rd. No. 48; abt. 4 miles on Rd. No. 9. $522,000 fed and co. funds (Douglas County) will probably be available this year.

N. Car., Ahoskie—City plans street paving; will receive bids in about 90 days. Carolina Engrg. Co. Engrs. Wilmington, N. Car.

N. C., Morgantown—$150,000 bonds voted by City for street impvts. R. W. Pipkin, Mayor.

N. C., Winston-Salem—This year's plans for impvts. in Winston-Salem involve expendt. of about $1,600,000 for street paving, $300,000 for water and sewer extensions; $350,000 for new sewage disposal plant; $250,000 for new filter plant, etc., etc.

Ohio, Cleveland—Cuyahoga County will take bids in Spring for paving about 3 miles Kinsman Rd., brick, $278,600; Fitzwater Rd., brick or conc., $114,000; Willow Rd., rein. conc., $493,200; grading about 5 miles Wolf Rd., $47,900. F. Lander, Court House, Engr.

Okla., Sapulpa—Creek County considering hard surfacing 5 rds., totaling about 40 miles: 9 miles thru Tiger Twp.; 12 miles to Mannford; 6 mlies in Mannford Twp.; 5 miles west of Sapulpa on Ozark Trail thru Bristow; 9 mi. east of Bristow on Ozark Trail; fed. aid $425,000. County and Twp., paying like amount.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Canneiton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Canneiton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Ore., Medford—Highway Commission in Portland recently agreed at meeting, to advertise in March or April for bids to macadamize 9 miles of road now being constructed betw. McCloud and Cascade George on Crated Lake Hwy., work to be done without cost to County; also to widen Green Springs and Siskiyou mountain roads where necessary for safety. Resolutions passed by State Chamber of Commerce and County Judges and Co. Commrs., requesting Congress to appropriate $280,000 to complete roads in Crater Lake National Park. Geo. H. Cecil, Dist. Forester, has recommended to Dept., the expenditure of $42,000 on upper Blue Ledge rd., to connect with Klamath River hwy. in Calif.

S. D., Canton—Plans being made for paving 20 blocks on 5th and Main Sts. About $75,000. W. L. Buell & Co., 205 Davidson Bldg., Sioux City, Ia.

S. Dak., Pierre—Following projects proposed for award by State Hwy. Comn., probably in March or April: Pennington Co., FAP 169, Rapid City S. 9.5 miles; Haakon Co., FAP 162,—Midland to Philip, approximately 17.1 miles; Dewel Co., FAP 179, bet. Clear Lake and Minnesota line, 12.0 mi.; Faulk, Spink and Edmund Cos., FAP 173 bet. Faulkton and Chelsea, bet. Cresbard and Ipswich, approach 44.0 miles; Bon Homme Co., FAP 167-A, bet. Tyndall and Springfield, 10.3 mi.; Bon Homme Co. FAP 178, thru Tabor, 6.9 miles.

S. D., Vermillion—City plans to pave 50 blocks of streets this season. C. L. Vaughn, City Aud.

Tenn., Murfreesboro—Rutherford Co. plans to build fed. hwys. to Bedford, Cannon and Coffee Co. lines; $300,000 bonds voted; also rebuild turnpikes in County for which $450,000 bonds have been voted.

Tex., Bellville—Austin County, Precinct No. 1, plans to build rds. Contemplates voting on $450,000 bond issue.

Tex., Brownsville—$150,000 bonds sold by Haywood Co. Plans bldg. Bristol Hwy. from here to Tipton Co. line.

Tex., Columbus—Colorado County plans to construct 6.9 miles 18-ft. conc. with 1-in. asphalt top road on Weimar-San Antonio Rd. Est. cost $215,000. E. B. Mayes, Co. Judge; B. H. Faber, Co. Engr.

Tex., Goose Creek—$100,000 bonds voted here for street impvts.

Tex., Sherman—Grayson County plans to lay permanent type highways and improve county road. May vote on $5,000,000 bonds. H. M. Scott, Co. Engr., Denison, Tex.; R. M. Carter, Co. Judge.

Tex., Sulphur Springs—Hopkins County plans 33 miles macadam with inverted penetration top road from Hunt Co. line to Franklin Co. line; F. A. P. 431. Est. cost $741,043.90. J. B. Rieman, Co. Engr., R. E. Bertram, Co. Judge.

Texas, Vernon—Wilbarger Co. plans to pave Colorado-Gulf Hwy. from connection with paved highway thru Wichita Co. at Electra, thru Harrod and improving roads no. of Harrod. $150,000 bonds voted here.

Va., Roanoke—Lions' Club interested in bldg. Virginia Hwy. from Washington, D. C., thru Leesburg, Harper's Ferry, Berryville, Winchester, Sew Market, Luray. Harrisonburg, Staunton, Lexington, Natural Bridge, etc., then to Washington again.

Wash., Hoquiam—City will expend nearly $250,000 for street impvts. this year. Emerson Ave. paving is largest job, est. to cost about $100,000; will have 36-ft. conc. roadway and 6-ft. sidewalks.

Wash., Seattle—Asst. City Engr. Tiedemann announces that a hearing on one of the largest paving projects of the year in Seattle will be held by Council about middle of March. Work contemplated will involve about 7 miles paving in dist. west of Fremont Ave. and bet. 42nd and 57th Sts. Prelim. estimates indicate impvt. will require expendt. of about $400,000.

Wash., Seattle—King Co. Commrs. passed resolutions recommending that State construct new hwy. to connect 15th Ave. N. W. with new Seattle-Everett Hwy. now under construction. Thos. R. Beeman, King Co., Engr., estimates cost of link at $274,000.

W. Va., Bluefield—City will soon receive bids for 6 miles paving, including re-paving 2 business thoroughfares with sheet asphalt over old brick pavement. Approx. cost $400,000. For detailed information address Manager Ridley.

Wis., Madison—City contemplates improving several streets this year. E. E. Parker, City Engr. Est. cost $493,664. H. C. Buser, City Clerk.

Wis., Oshkosh—Co. Bd. of Supvrs. voted $205,000 bond issue for impvt. of Oshkosh-Ripon Rd. beginning at Oshkosh and running SW to Ripon, 18 ft. conc, $100,000; Neenah-Mikesville Rd., Neenah Cemetery N and NW on Co. Trunk B, thence west on Co. Trunk B; also known as Neenah-Winchester Rd., 18 ft. conc. $105,000. F. C. Steiner, Commr.

SEWERAGE AND SEWAGE TREATMENT

Ala., Birmingham—Will soon receive bids for supplementary sewerage system in down town district; 8-30 inch mains. Est. cost $275,000. A. J. Hawkins, City Hall, Engr.

Alaska, Juneau—Bill seeking authority to float bond issue in sum of $200,000 for Juneau introduced in Congress by Delegate Sutherland. Bond issue is to provide for constr. of perm. sewer system here.

Cal., Brea—City trustees considering plan to join with cities of Anaheim, Santa Ana, Fullerton and Orange in joint outfall sewer project. Additional section will cost $112,471. R. W. Phelps, City Engr.

Cal., Carmel—Plans being prepared for sewers i nDist. 1—San Carlos to sea and from Santa Lucia to Ocean Ave. Est. cost $100,000. H. D. Severance, Pacific Grove, Engr.

Cal., Huntington Park—City Engr. Howard McCurdy, Pacific Elec. Bldg., Los Angeles, preparing plants for lateral sewer system for City of Huntington Park. It is planned to start work about same time as main trunk sewer starts.

Cal., Los Angeles—New proceedings for constr. of Arroyo de la Sacatella storm sewer system will be instituted at once following action of City Council in instructing City Atty. and Engr. to prepare ordinances abandoning former proceeding and declaring new intention for work. New proceedings for storm drain system, which will serve approx. 16 sq. miles of City west of Alvarado Street will be under 1911 Act. Plans for Metropolitan Sewer Dist. No. 1, embracing territory bet. Pasadena and Long Beach, being worked out in offices of Co. Surv. Rockhold. Portion of Orange County included. Proposed plan contemplates constr. of 10-ft. trunk sewer from foothills of Pasadena to some point in Orange Co., probably bet. Sunset Beach and Huntington Beach. Laterals from this line will serve Compton, Watts and other cities in territory adjacent to main trunk line. Outfall will be approx. 1 mile in length. Plans are being considered for treatment of the affluent.

Cal., San Jose—Plans prepared for sewerage system. Est. cost $100,000. C. D. Marx, Stanford University, Palo Alto, Engr.

Ont., Ft. Erie—Sewers planned to be constructed in 33 streets no. of Garrison Road. Est. cost $100,000.

B. C., Vancouver—It has been decided that test borings for Alma Rd. imperial street sewer outfall should begin at once on day labor plan under supervision of JoJs. Slater, Drainage Board's Engr. If borings are satisfactory it is expected to begin work shortly. Est. cost of impvt. $268,000.

Ont., York Twp.—Messrs. James, Proctor and Redfern, Ltd., Toronto, Cons. Engrs. in charge of the $1,000,000 sewage disposal plant and trunk sewers for York Twp.

Ga., Atlanta—E. Buchanan, Chmn. of Council Sewer Comn., will expend $106,000 for impvts. and extensions to sewer system.

Ill., Broadview—Town plans to construct san. and trunk sewers at cost of $150,000. Consoer Engrg. Co. 140 S. Dearborn St., Chicago, Cons. Engrs.

Ill., Depue—Town considering constr. of san. sewers in various streets. Est. cost $90,000. Consoer, Older & Quinlan, 140 S. Dearborn St., Chicago, Cons. Engrs.

Iowa, Edgewood—Plans being prepared for sewers and disposal plant; 3½ miles 8 and 10 inch pipe. Con. Engrs., W. E. Buell & Co., Davidson Bldg., Sioux City; F. T. Pickington, City Clk.

Ill, Elgin—$700,000 bonds voted here and bids will be advertised for about June 1st for sewage treatment works ($450,000), collecting sewers, ($270,000. M. H. Brighton, 25 Spurling Bldg. Engr.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Incinerators.
William F. Morse.

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Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Ill., Staunton—Prelim. plans being prepared for storm and san. sewers, ranging from 10 to 60 inches; cost to exceed $100,000. E. F. Harper, care Missouri Athletic Club, St. Louis, Mo., Engr.

Minn., St. Paul—City contemplates laying 19 miles main sewers, Belt Line system, $1,000,000; also 7 or 8 miles main sewers Trout Brook system, $1,000,000; both concrete, up to maximum width of 9 ft. G. H. Shepard, City Engr.

Neb., Fremont—$100,000 bonds voted for sewage disposal plant. L. M. Roessler, City Engr.

N. Y., Youngstown—Election planned to vote on $75,000 bonds for disposal plant. Will mature in Spring. Hopkins Engrg. Co., Cutler Bldg., Rochester.

N. C., Winston-Salem—This year's plans for improvements include expendt. of $300,000 for sewer and water extensions and $350,000 for new sewage disposal plant.

Ohio, Massillon—Stark County (Canton) plans sanitary sewerage system in large area southwest of here. Est. cost $150,000 or more. Engineer not selected.

Ohio, New Philadelphia—City contemplates construction of san. sewers in Bway., 6th, 7th, 5th, Howe, 3rd, Howe and 2nd Streets, etc., etc. Est. cost $67,582. G. E. Arnold, Engr., City Hall.

Ohio, Norwood—City plans to lay 1,050 ft. 8x10 ft. rein. conc. sewer in Duck Creek—Edwards Rd. to Williams Ave. Est. cost $90,000. A. Baker, City Hall, Engr.

Okla., Tulsa—Plans being prepared for City and bids will be received in April for 12-22 in. storm sewers. Est. cost $800,000. C. Schultz, City Engr.

WATER SUPPLY AND PURIFICATION

Ala., Birmingham—Alabama Water Co., (Jno. B. Weakley and Eugene Fies, Executives, have completed plans for construction of water works in small towns in State including Leeds and Irondale in Jefferson County and at Hartselle in Morgan Co. Est. cost from $50,000 to $100,000 each. Company will also expend $175,000 for exten. of mains to Hueytown and Dolomite; construction by Company. F. C. Basenberg, Engr.

Ala., Bessemer—Alabama Water Co., will expend approx. $200,000 for impvts. to water system; will install water mains to Hueytown and Dolomite, etc.

Que., Three Rivers—Plans and specifications to be prepared for erection of $250,000 filtration plant. Art Surveyor & Co., 511 St. Catherine St., W., Montreal, Engrs. in charge of work.

Fla., Sanford—Plans being made for new water works plant to be provided for by $375,000 bond issue.

Ia., Des Moines—Estimate $350,000 for proposed water works improvements to include pipe extensions, meters, feeder mains, about 5,000 lin. ft. increase in galleries, etc. K. C. Kostberg, City Engr.

Ia., Marshalltown—Petition being circulated requesting Council to call election to vote on $300,000 water system bonds. Anne McMahon, City Clk.

Ia., Des Moines—Considering expendt. of about $355,000 for 5,000 feet increase in galleries, feeder mains, pipe extensions, meters, tools and equipment. E. McGlothlen, City Clk.

La., Alexandria—Committee appointed with J. E. Thorsell, local as directing head, as result of conference of business men to discuss feasibility of financing constr. of Bradford Hydro Electric Gravity canal project, designed to connect Red River and Calcasieu River; also to supply electrical energy to Alexandria, Lake Charles and cities along route. Plant est. to cost $4,000,000.

Mass., Brockton—Appropriation of $750,000 for constr. of additional water supply from Silver Lake requested; also for main extension in City.

Minn., Caledonia—Plans being prepared for pumping station installation of 80,000 gals. per minute capy. Est. cost $428,000. Central States Eng. Co., Muscatine, Iowa, Engrs.

Minn., Minneapolis—Plans completed for constr. of water plant at Fridley site. Est. total cost at $2,700,000, of which $350,000 will be expended this year. N. W. Eisberg, City Engr.

Mo., Kansas City—Burns & McDonnell Engineering Co., Cons. Engrs., for water works impvts. as follows: Prelim plans approved and final surveys and plans under way at Kearney, Neb. Harry H. Mole, City Engr. in charge. Est. cost $135,000; also surveys, ests. and report authorized for additional water supply, filters and other impvts. in Anacortes, Washington. Est. cost $100,000. At Sedalia, Missouri surveys in progress for proposed reservoir sites, larger feeder mains and other improvements. Est. cost $250,000. At Independence, Missouri, surveys and plans under way for 2-million gals. reinf. conc. reservoir and cast iron feeder mains. Est. cost $175,000.

Mo., St. Joseph—St. Joseph Water Co., contemplates expendt. of $600,000 for impvts. in pumping, purification, transmission and distribution facilities.

Neb., Kearney—Voted in favor, here, of $135,000 bond issue for erection of new municipal water FIVE—MUNICIPAL ENGR—SHARP works plant. Includes oil driven semi-Diesel engine. M. E. Burke, City Clk.

N. Y., Rockaway Beach—Report urgent need for extension of water mains here. Est. cost $2,175,000.

N. Y., Utica—Increase capitalization of Consolidated Water Co. $1,000,000 to be utilized for bldg. conduit and main from Deerfield reservoir.

N. C., Winston-Salem—This year's plans for impvts. inciude expendt. of $300,000 for water and sewer extensions and $250,000 for new filter plant.

Oregon, Albany—Undertaking to procure mountain water system to supply all the valley towns of this section is now under way; source of supply to be at head of McKenzie river at Clear Lake. Filing on rights of site recently completed. Entire supply line estimated to cost $7,000,000 and will be 179 miles long. It is planned to pipe the water to a central plant. Temporary organization to carry out negotiations with other valley towns, formed here under name of Pure Water Development League.

Tenn., Knoxville—City considering issuance of $2,100,000 water works bonds.

Va., Staunton—$700,000 bonds voted for water supply system; construction will begin in May. W. F. Day, Mgr. Fuller McClintock, Engrs., 170 Broadway, New York.

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Good Roads Machinery Co., Inc.

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Austin-Western Road Machinery Co., The

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The Barrett Co.
Standard Oil Co. (Indiana)
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Austin-Western Road Machinery Co., The
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Pawling & Harnischfeger.
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Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

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Sauerman Bros.

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Madison Foundry Co.

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Stewart, W. H.

Sewer Forms.
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Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

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Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

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Austin-Western Road Machinery Co., The

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Pawling & Harnischfeger.

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The Barrett Co.

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Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

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Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

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Little Giant Co.

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Lee Trailer and Body Co.

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Murphysboro Paving Brick Co.
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Protecting the drives at Vassar

VASSAR'S drives are extensive — as wide as city streets and as well constructed.

Every foot of pavement in Vassar's grounds is protected from stresses of expansion and contraction by Carey Elastite Expansion Joint. Not a crack or a hump mars the surface of these beautiful roadways.

The temperature range is extreme in New York State and this variation creates considerable slab-movement that must be absorbed. Engineers and contractors agree that Elastite Expansion Joint is the most practical and efficient easement of these expansion strains. Write for literature and sample.

THE PHILIP CAREY COMPANY
40 Wayne Ave., Lockland, Cincinnati, Ohio

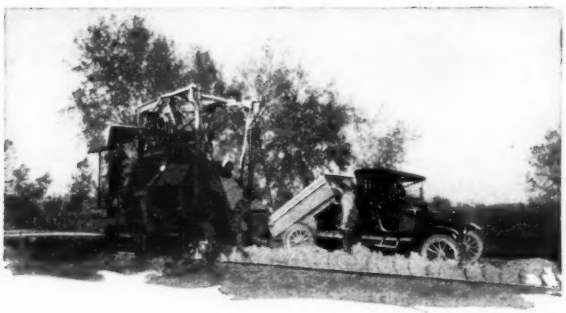
Carey Elastite

NAME REG. U.S. Patent Office

PROVED AND ACCEPTED
EXPANSION JOINT

4-24

Elastite Expansion Joint is an elastic resilient material composed of two sheets of asphalt-saturated felt between which is "sandwiched" a body of carefully refined asphaltic compound.



Warford the Road Builder

"We cannot speak too highly of the Warford Transmission, for we feel that it is really the making of the Ford Truck."
John C. McCusick,
McCusick Contracting Co., Minneapolis

Warford, the selective type transmission for Ford Cars and Trucks, proved in the gruelling test of road building, has made the Ford Truck the favorite of highway contractors throughout the county.

Conspicuous service at road building, the toughest job of them all, is being given by Warford equipped Fords over the breath-taking grades of Colorado, the plains of Iowa and in the fickle climate of Michigan where the contractor gambles with the weather. The speed that Warford gives the Ford insures his profit.

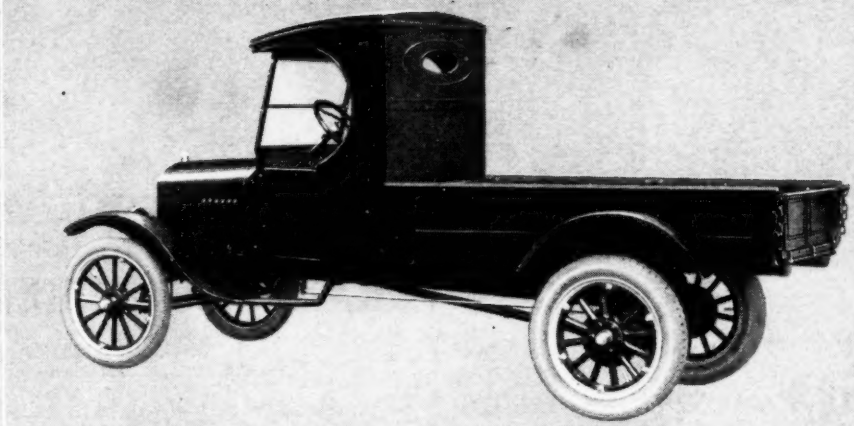
Letters from the Michigan camps, in the very heart of the automotive industry where the newest wrinkles in car and truck engineering are brought forth and tested, are unanimous in praise of the added pulling power, added speed and greater economy of operation and maintenance that the Warford Transmission has given the Ford Truck. These letters stand confirmed by repeat orders.

With Warford, the Ford Truck pulls a full two tons through the roughest going. It won't stall in the subgrade. It is guaranteed to pull this double load wherever there is traction. On hard roads Warford makes your Ford a speed truck.

Warford gives you this double duty unit at one third the cost of any other two-ton or speed truck. Ask your Ford dealer or write us.

Warford
AUXILIARY TRANSMISSION

The Warford Corporation - - 44 Whitehall St., New York



The new Ford all-steel body and weather-proof cab mounted on the Ford worm drive chassis at $490 f. o. b. Detroit, is the world's lowest priced complete one-ton truck.

A Preference Based on Quality

There is deep significance in the fact that 78% of all trucks of one ton or less capacity in the United States are Fords.

This overwhelming preference for Ford haulage units has its basis in the low cost of Ford transportation, the rugged construction of the truck itself, and its unusual adaptability to every line of industry.

Mechanical excellence, simplicity of design and ample power are further factors that have contributed to the popularity of the Ford One-Ton Worm Drive Truck.

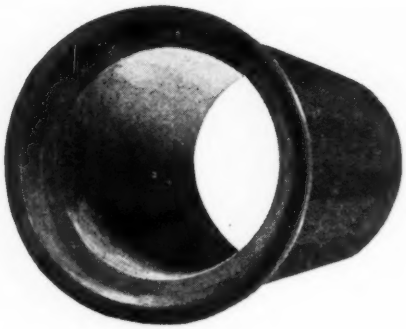
As a logical step in providing dependable transportation at the lowest possible cost, the Ford Motor Company is now producing an all-steel body and steel weather-proof cab mounted on the Ford Truck Chassis, selling at the remarkably low price of $490.

Merchants Standardizing their delivery systems on Ford One-Ton Trucks have available the facilities and assistance of over 33,000 Authorized Ford Service Stations, conveniently located to their business.

Ford Motor Company
Detroit, Michigan

See the nearest Authorized Ford Dealer

Ford
CARS · TRUCKS · TRACTORS



Clay—
the logical sewer pipe

ALTHOUGH conditions have become more complicated and requirements more exacting, man still depends upon the same basic products that he has depended upon from the beginning. Always we have wheat and meat for food; iron for tools; baked clay bricks and tile for building.

And Vitrified Salt Glazed Clay Sewer Pipe for building sewers is still unrivalled. Ground chemicals, sewer acids and electrolysis can not harm Vitrified Clay, for it is made of the ground itself; there is nothing in it for chemicals and acids to attack!

Properly laid, a permanent installation is assured, for this pipe is as enduring as rock itself.

For the economy of an installation that can not wear out, specify Vitrified Salt Glazed Clay Sewer Pipe.

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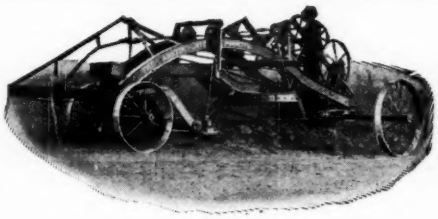
VITRIFIED Salt Glazed CLAY
Sanitary Sewer Pipe



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AND
GRADER-SCARIFIERS
14 Models

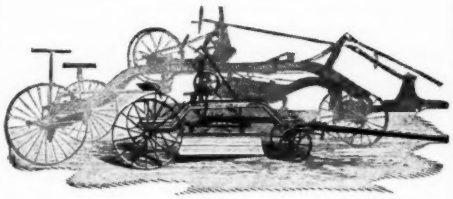
You don't have to look further than the first twenty-one pages of General Catalog No 21-O to find the machine exactly suited to your needs.

The graders range in weight from the Midget at 1,000 pounds to the No. 20 at 11,500 pounds.

Scarifiers can be attached to all graders of at least standard size, but for a really efficient outfit, choose the Austin Rip Snorter, which scarifies and grades at the same time; or the Western Scarifier, big brother to a grader on the hardest jobs.

It will pay you to read the whole story of Austin-Western Graders

Send for Catalogue No. 21-O.



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Subject to normal heavy traffic, the Madison Pike leading south from Cincinnati to the Latonia race track carries an unusual load during the racing meets. This pavement was constructed of Kyrock on a cement concrete base in 1920. Today it is in perfect condition, free from holes, rolls or ruts and showing no wear from abrasion.

Kyrock does not shove, roll or bleed because it is thoroughly mixed by Nature. Each grain of the aggregate is completely coated with bitumen. Kyrock wears because its mineral aggregate is pure silica sand, hard and angular. The bitumen in Kyrock does not lose its life. It has been seasoned for thousands of years. Kyrock is laid cold. There is no danger of shortening the life of the pavement by burning the bitumen, as in the ordinary hot mixed asphalts.

Kyrock is shipped ready to lay cold on any standard base. Shovels, rakes and roller are the only equipment needed. The material is not subject to damage from the elements and may be stored in the open.

Kyrock is always uniform. All rock asphalt must pass a series of laboratory tests before being shipped from our plant. Kyrock shipped today is the same as that used on the Madison Pike, the Camp Knox Road at Louisville, and other famous Kyrock roads.

Our engineering department co-operates with engineers, contractors and officials in the design and construction of all Kyrock pavements. Literature and specifications mailed on request. Write for brochure M. C. E.

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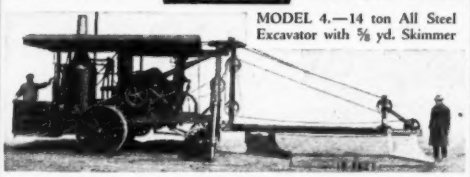
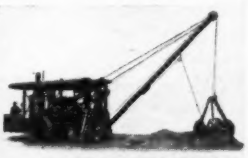
MODEL 4.—14 ton All Steel Excavator with ⅝ yd. Skimmer



The KEYSTONE is a highly versatile traction steam shovel with all the efficiency of specialized design, usable with three different interchangeable scoops – *Skimmer, Ditcher and Clam Shell*—for Road Grading, Trenching, Back-Filling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials. Can be equipped with electric motor drive for use in buildings. Saves first cost, moving cost and upkeep and is readily sold or rented for any sort of excavation job. A reliable road shovel of remarkable adaptability to other uses.

The heavy Keystone Skimmer Bucket, ⅝ yd. capacity, has a horizontal crowd of 14 feet and fills itself at one shot on a six inch cut. It leaves a smooth surface, finished to grade and thus dispenses with costly hand-trimming. Shallow digging on hard material—old macadam, paving blocks, concrete and asphalt—is keystone work. Made in two sizes: Model 3, 10 ton and Model 4, 14 ton. The good Keystone Digging ideas in our catalogs and advertising sheets have made money for 1500 Contractors in the United States. Ask for them.



Model 4, with Boom extension and ½ yd. Clam Shell Bucket

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Keystone stands on the solid. No cribbing needed, no danger from cave-in, of machine sliding into excavation. Any width or depth to 20 feet. There is 4 feet of water in this 12 foot ditch. The Keystone is adapted for hard going among roots, boulders, etc., and cleaning out blasted rock.

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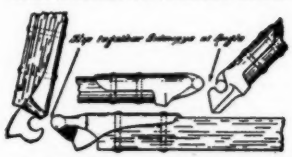

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Truscon Contraction Joints allow for expansion and contraction of concrete. When joint opens it is easily filled with asphaltum or bitumen. Used longitudinally, it serves as a traffic marker down center of pavement.

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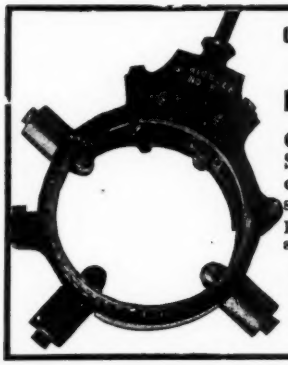

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Mr. Wm. Oberly, Superintendent of dredging on Chesapeake and Delaware Canal Contract of W. H. Gahagan, Inc.

Where it paid to shoot dirt

WHEN W. H. Gahagan, Inc., of Brooklyn, N.Y., contracted to excavate 5,600,000 cubic yards of earth to widen and deepen the Chesapeake and Delaware Canal, they were to meet conditions which they could have not anticipated. The sticking of the clay and sand composition of the bank cut the efficiency of their dredge by 50%, and a hanging of the banks, which fell into the canal, produced damage to construction equipment.

Now by the use of du Pont R. R. P. (Judson) in cartridges in wet, well drill holes, the material is entirely loosened. The dredge is enabled to work at 100% efficiency and excavation is progressing rapidly and satisfactorily without danger of the banks falling.

As a result of its 122 years' experience in the manufacture of explosives and constant study of their performance, the du Pont Company is enabled to supply the type of explosives best suited for any job—no matter how difficult.

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Progressive counties and townships everywhere are determined to put their primary and lateral roads into usable condition and keep them that way by constant patrol. Power, traction and speed are highly essential for this maintenance work. Teams are too slow and expensive for dragging and smoothing dirt roads. That's why the "Caterpillar"* is recognized as the one logical power for this purpose.

Officials have found that other kinds of power lack the ability of the "Caterpillar" to get out on the road after every rain, pull a grader and maintainer when the roads are wet, in level or hilly country, and under all other conditions of patrol maintenance. In covering the most miles per day—any day—the "Caterpillar" cuts the cost of maintenance per mile and per year.

There is a "Caterpillar" of size and capacity to fit the road-tax funds of each community. The 2-Ton insures low-cost working on the lighter jobs; the 5-Ton is the choice of experienced public officials and road contractors for moderate power demands; and the 10-Ton is supreme in the heavy duty field. Let us give you facts and figures on "Caterpillar" economy.

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REPAIRING WATER AND SEWER WORKS WITH GUNITE

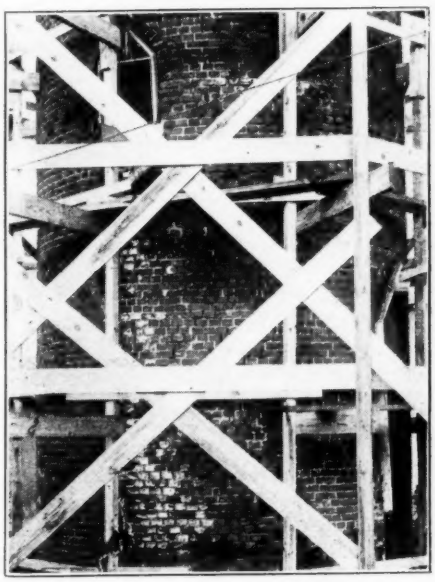
By L. B. Penhallow, Chief Engineer, Indiana Gunite and Construction Co., Inc., Board of Trade Bldg., Indianapolis, Ind.

Occasionally architects and engineers are confronted with repair problems hard to execute within reasonable costs. Two rather unique and economical repair jobs have been made during the past year in Indiana.

Coating Water Tower at Bedford, Ind.

At Bedford, residents located near the North Water Tower became greatly concerned over the badly deteriorated condition of the brick stand pipe, supporting the 48-ft. steel water tower. This base was built with 24-in. brick walls and was 13 ft. in diameter, and 68 ft. high. While the structure was not in danger of failure or collapse, the mortar joints on the outside surface were badly disintegrated so that some of the brick had fallen out and cracks were appearing, as shown in the accompanying picture. Several attempts had been made to plaster the worst places with cement mortar but they had been unsuccessful in securing a good bond and getting the plaster to stay in place.

A scaffold was erected around the structure and the entire exposed surface was thoroughly cleaned by a sand-blast with the cement gun. This process removed all loose mortar, as well as all the disintegrated portions of brick. After the cleaning was completed, Gunite in a mixture of 1:3 Portland cement and sand, was "shot" to a thickness of not less than ¾ in. at any point, filling all holes and cracks and increasing the diameter of the tank 1½ in. The density of the cement gun product has to this date prevented further weathering or disintegration due to its imperviousness, which has kept out all air and moisture and has eliminated entirely the harmful freezing and thawing action which had proved so disastrous. Due to the pressure of the application, which was approximately 40 lbs. per sq. in., the penetration of Gunite into all the



OLD BRICK TOWER AT BEDFORD, IND., BEFORE COATING WITH GUNITE.

WATER TOWER AT BEDFORD AFTER COATING WITH GUNITE.

cracks and pores in the brick, secured a perfect bond.

The cost of this work compared to encasing with a concrete ring was very low, inasmuch as all the equipment was located on the ground, the Gunite being "shot" through a hose to the point of application, thereby eliminating a tower and necessary hoisting equipment, which would have been necessary for a poured concrete job. No forms were used and the finish was the natural cement gun finish, untouched by hand.

Relining an Indianapolis Sewer

In another instance, approximately 600 ft. of a 5-ft. concrete sewer, located in Indianapolis, was inspected and found to be badly worn and erroded. At one point, three or four sections were completely shattered and it was necessary to excavate from the street to install new sections of pipe. The balance of the sewer was all re-lined with Gunite, "shot" under 45 lbs. pressure from the equipment which was located at one point on the street. As the sewer was primarily a storm sewer no great difficulty was experienced with water, except during a rain when the work had to be temporarily postponed. Under ordinary conditions a sand bag dam was placed ahead of the section which was being "shot". On account of the density and perfect hydration of Gunite, a sufficient set was obtained so that the failure of the dam, which occurred when the back water pressure exceeded the strength of the temporary obstruction, did not wash the newly placed material. Results were highly satisfactory, even though conditions were rather confining for an operation of this nature. The nozzle operator was kept in constant communication with the machine operators and those on the surface by means of a storage battery head telephone set.

LINING CONCRETE SEWER WITH GUNITE, SHERMAN DRIVE, INDIANAPOLIS, IND.

CONCRETE SEWER IN SHERMAN DRIVE, INDIANAPOLIS, AFTER LINING WITH GUNITE.

Work on the Bedford Water Tower was under the supervision of Mr. J. W. Mallott, City Engineer of Bedford, Indiana and was executed by the Indiana Gunite & Construction Company of Indianapolis, General Contractors and Specialists in Cement Gun work. The sewer project was handled by the same company under direction of Mr. J. L. Elliott, City Engineer of Indianapolis.

SERVICE—THE SLOGAN OF THE PROGRESSIVE HIGHWAY DEPARTMENT

By A. R. Hirst, State Highway Engineer, Capitol Annex, Madison, Wis.

Webster defines "service" as: "Labor done for another." "An act conferring advantage or benefit." Every activity of every good highway department comes within these definitions, because every act

is labor for others and is, at least, intended to confer benefit to the people of the commonwealth.

There are almost as many types of highway departments in the United States as there are departments. Their activities vary in accordance with the public state of mind, the amount of political control, and the inspiration of those who head the departments.

Some state highway departments are content to build or to maintain, or both, just as someone else determines they shall do. The process is purely mechanical. They are told by the legislature or by the governor to do certain things and they do them. Beyond that they do not go.

Other highway departments keep their eyes open and their ears to the ground and after some other state has done something and an emphatic verdict of approval has been rendered as to its value, these departments follow the leaders. It is true they keep a year or more behind the procession, but, nevertheless, they follow along.

There are other highway departments whose conception of the service they should render is, in our opinion, much nearer the ideal than that of the standpatters or assentators. These departments are often in trouble because they do something and because their activities often precipitate them into domains hitherto held sacred to the legislative bodies or to the executive.

A Definition of State Highway Service

If I were asked to define the service which a state highway department should render to a commonwealth, the definition would be somewhat as follows:

A state highway department should bend every effort toward giving the people of its state safe, dependable and rapid statewide highway transportation at an honest cost, fairly distributed between the various classes of taxpayers in accordance with the benefits received.

If a highway department is to fulfill this definition, it is precipitated into the economic, tax, legislative, railroad and, to some extent, political fields in addition to its ordinarily assumed to be fields of building an d maintaining highways.

Legislation

Take the matter of legislation. A highway department may hold itself entirely aloof from matters of legislation; take just what the legislature determines the people should have and do the best possible with the means and the laws provided. This is a negative attitude and few states have attained results in which the highway department has assumed this attitude.

The field which legislation affecting highways, their safety and their use, may cover is almost infinite. Just mentioning a few things a comparatively short list would be as follows:

1. Laws for the safety of persons. This includes protection of life at railroad crossings, speeding, policing, drivers' licensing and sign menace, lights, marking and signing, etc.

2. Laws for the safety of motor property. This includes policing, drivers' licensing, also, liability insurance of motor vehicle owners, registration, protection against theft, etc.

3. Proper laws for financing the highway program. This includes license fees, motor fuel taxes, and the whole broad field of economics, taxation and consideration of relative benefits.

4. Proper laws for creating and financing highway organizations. This gets into the whole broad field of government and of proper control of public enterprises. Includes the form of governing bodies, provision for their continuity, consideration of the relationships between the federal government, the state, the counties, and the lesser units and the proper coordination of the activities of each.

Each of the sub-heads of what may be called the four main legislative heads is a broad field in itself, and unless a highway department is fitted to think out these various problems and to offer effective advice and even effectively drafted bills, it is quite sure that effective bills will seldom be framed or enacted.

Broad as the above fields are they are but a small fraction of the general field of legislation which must be covered by a state legislature at every session. It is impossible that untrained minds, no matter how wonderful the minds may be, can, in the course of a short session of the legislature, formulate adequate highway policies and plans for the next two years without some expert and disinterested assistance and guidance.

Therefore, included in the service which should be rendered by a progressive highway department is an impartial legislative service of the best character. It is a consulting engineering field of the highest importance and has been too little filled in the average American state.

The policy of *laissez faire* is not sufficient. A casual inspection of the highway bills proposed by the average member of the average legislature will convince any fair-minded man that there must be intelligent cooperation between the executive, the legislative body and the state highway department if sane and effective legislation along any of these lines is to result.

Progress Fixed by Legislation

The highway progress of any state is not determined by the personnel or ability or lack of ability of the state highway organization. The progress is fixed by legislation. Nothing can be done without proper legislation. No good highway department can be created or continue to exist, unless the ground-work on which it functions is well conceived. This is a factor too often entirely disregarded in the criticism of results.

Unfortunately, if the executives of highway departments conceive it to be their duty to help in preparing the frame-work of the structure—the legislative program—it is usually considered that they are impertinent and interfering with a matter which is not their business, but by American custom is the business of the legislature and of the executive. This state of the public mind is extraordinarily unfortunate and in this, and in almost every other field, has resulted in a mass of ill-devised, unworkable, and foolish statutes, which would strangle all American progress if most of them were not dead-letters from the moment of their enactment.

We have plenty of pride, prejudice and passion in the legislative field, but very little calm, well informed and well balanced legislation. It is not surprising that this is true, because the members of a legislature cannot possibly survey the field they are supposed to survey and come to several thousand correct conclusions relative to hundreds of matters within a few months.

The Most Important Service

If I were asked to name the first service in importance that a state highway department should render its state, it would be the giving of impartial, dispassionate, informed advice to the legislature upon all the highway problems of the state, including highway financing.

Highways extend into every unit of government. Every class of highway exists in most units of government. The development of some units of government in highway matters and the total lack of development in others means lack of adequate development of the whole highway system.

Too many states consider that state service stops with a small fraction of the roads of a state more or less provided for. It is our conception that the responsibilities of a state government extend to every highway in the state. This does not mean that every highway in the state must be state controlled, but it does mean that the state should take an intelligent interest in the control of every mile of highway.

Its laws and practice should be designed to build up adequate state, county and local organizations, so that every road may get the attention which it deserves in the proportion of its deserving. Again a state highway department can adopt a negative attitude of looking after its own, but again no statewide results can be secured without effective laws providing for all roads. Statewide highways do not just grow like Topsy; they come from right basic ideas translated into legislation.

Political Influence

It is needless to say that the highway organization of every unit of government should be non-political. It is rather peculiar that, as a general proposition, the highway organization of the lesser units of government are less political and subject to fewer changes than have been the highway departments of the states.

In early discussions of the American highway problem, great stress was laid by the advocates of state boards and commissions upon the prevalence of politics in the administration of highways by the lesser units of government. The millennium was to come when highways were state controlled.

Too Rapid Shifting of Personnel

At the annual meeting of the American Association of State Highway Officials in December, 1923, the executives in charge of highway work in eleven American states were the persons in executive charge of the same states at the time of the Louisville meeting in December, 1919. According to Mr. H. K. Bishop of the Bureau of Public Roads, in 8 years the 48 states have had 117 different executives of their highway departments, 34 of these serving 1 year, 35 for approximately 2 years and 13 around 3 years. Fifty-nine percent of all of them served their states for a period of 2 years or less, while 70

percent of them served 3 years or less. The average life of the chief executive of a state highway department, according to Mr. Bishop is about 3 years.

Reflection that these men are in responsible charge of programs varying from possibly as little as $1,000,000 to as high as $40,000,000 per annum per state, and that the total expenditures under their charge now approximate $750,000,000 per annum, is a rather remarkable commentary on the American attitude toward their greatest public work.

Again it is not easy for the executive of highway departments to point these things out. The impression is always that they are thinking and talking of themselves and promoting their own continuance in the public service.

If highway transportation was the simple thing it was three or four decades ago, these constant changes would make little difference, but the highway field is becoming utterly complex and an extremely expert one. Almost all of the states are getting results, given a definite piece of construction or maintenance to do, but as far as the broad fields of highway engineering and of highway transport are concerned, many of the American state highway departments are as "babes in the wood."

The executives of many of them, without the slightest previous training to fit them for this broad field, have been thrown into the midst of a chaotic and intricate problem and are naturally completely baffled, and just as naturally, progress of their states in the solution of these problems is negligible.

I have spent a very considerable part of the time allotted to me in discussing the broader fields into which, I believe, the state highway departments must project themselves if they are to give real service to the people of their states. I imagine that most men would say that these fields are none of the business of a state highway department and that the state highway department should simply concern itself with building and maintaining roads as the people, through their authorized elected representatives, direct. Twenty years in the field of American highways has convinced me that quite the contrary is true. I am sure that if there is to be reasonable progress in any state, it must largely come from responsible, trained and expert assistance to legislation rendered by the state highway department.

As long as the highways plans and policies of states are determined upon the spur of the moment, as a result of political happenings or as a result of personal prejudice, just so long will that state either mark time as far as real progress is concerned or go backward.

Practically all services rendered by a state highway department depend upon legislation. The amount of money spent in construction, the distribution of the construction, whether for maximum traffic betterment or with no definite purpose, the character of construction, whether adequate or obsolete, depends almost entirely upon the means and methods of financing and locating the whole highway project, and, of course, these means and methods are determined upon by the legislatures of the several states.

There is no good in having visions or dreaming dreams about perfect or almost perfect highways unless they can be translated into the structures themselves, and the structures cannot be built nor properly located unless the laws permit them to be properly built and located.

Traffic Service

The same things are true in the field of traffic service, which means the broad field of maintenance. No state can give traffic service without good maintenance—not only of the comparatively small mileage of roads which the states have built, but of all roads making up a coherent system.

It did not just happen that in Wisconsin, for instance, we will patrol maintain systems of 20,000 miles of road in 1924. The germ idea of such a system first had to be thought out and then translated into legislation by public education and through hard work with the legislature on the part of the state highway department. Given the basic idea and the law, all based on sound reasoning, the result could not help but be sound and was sound. But the dream would still be a dream had it not been translated into legislative action to provide the money and the machinery to carry out the basic idea.

Thus came the Wisconsin system of maintenance; the idea of taking roads whatever their condition and doing the best possible for them. This is traffic service. The construction of detached sections of roads and the neglect of the intervening stretches is not traffic service, as has come to be realized in practically every American state.

The Wisconsin idea of numbering highways, of carrying these numbers on a map, so that "he who ran" might read and follow, first had to be thought out by someone who spent time on the problem and then had to be sold to the legislature so that the legislature would authorize it and provide the funds for the marking and the maps.

Again the thing did not happen in the mind of a man who had not thought of it. It came as a natural development of a study of so-called trails and highways and the conversion of the germ idea of marking a highway on the ground itself to a rational statewide and engineering basis.

Detours

Consider the matter of detours. Years ago to the average man a detour was just a necessary nuisance; to the average state and county highway official the closing of a road, and travel seeking its way like the lost tribe of Israel, was a matter of course. No attention was paid to the economics of the situation until trained highway men thought it out. No one even guessed that in many cases detours cost more to traffic than the cost of the piece of construction. There have undoubtedly been hundreds of miles of road and hundreds of bridges built in America, where the losses to the traffic far exceeded the cost of construction. The various highway departments have coped with this problem until it has become a recognized American standard that where a road must necessarily be closed, it is the public's duty as represented by the highway department closing it, well and intelligently to take care of the travel during the closing. This is a growth from the background of knowledge and did not come full-fledged from the skies.

Highway Maps

Take the matter of highway maps published by the states for the disinterested guidance of travel. States had published maps to show the progress of their construction but we believe it was not until Wisconsin published its first highway map in 1916 that there was issued a really honest guide to travel. Since that time many states are showing the kind of road so that the traveler may by looking at a map determine the surfacing or lack of surfacing of any route on any main road in the state, so that he may plan his journey from knowledge and with judgment. Some of the states have gone even further in the issuance of detour maps so that the traveler may plan his journey with a minimum of detour interference, even though detours in these days in most states are well maintained and well taken care of.

Snow Removal

Among the items of service which a state highway department in a northern state must now, or will have soon to include its activities, is the removal of snow, so that the main highways, at least, may be kept open twelve months in the year.

Again effective statewide action must be based upon proper legislation, and proper legislation on this subject is an intricate and difficult problem. As in all other fields, we have to contend with the extremists on both sides and with men who little realize the underlying economic, social, and financial phases of snow removal on a large scale.

With the tremendous increase in motor vehicles and the large number of transportation activities which are now motorized, it becomes inevitable that the main roads must be kept open because the maintenance of duplicate equipment is impossible. Large transportation operations predicated on one basis for eight months must be predicated on the same basis for the remaining months.

It is quite sure, however, that as long as in this northern tier of states probably the majority of motor vehicles are laid up for the winter months, there will be difficulty about the financing, solely at the general public expense, of snow removal for the direct benefit of the rather limited number directly served by the removal. The situation has many and glaring difficulties, but these must be met and the problem must be worked out on a basis which can be sold to the whole people of the state.

Having considered this snow removal problem for only ten years, I am not yet ready to propose a solution, but a solution must be found by someone. Undoubtedly it will be found within the next few years, because the definition of real highway service is not fulfilled until it becomes a twelve month service.

All of these items are items of service. The modern highway department is swinging widely away from the old idea that the proper building of a few miles of road, in accordance with the funds provided, is the whole function of a state highway department. The new conception is that a state highway department exists to move highway traffic with the

minimum of inconvenience and at a minimum cost, including in this cost not only the cost of the work itself but the cost of the traffic in negotiating the stretch of highway which must be reconstructed.

A Basic Difficulty

There we run into a basic difficulty in the present highway situation. The American public looks at cost, but they look only at the public cost; that is, that cost which is being paid out of the public treasury and raised by taxes. There has been no general public conception that highway transportation is an economic problem, and that in determining any problem all of the costs of the solution reached should be considered, and the costs of the various solutions balanced with all items of cost considered. These speculations, of course, bring up the whole field of relocations, shortness of distance, elimination of turns, gradients, character of surfacings, lengths of detours, cost of detours, saving in time, saving in cost of operation of motor vehicles. Problems will often be decided one way if only cost out of the public treasury is considered; in another way if public and private expenditures combined are considered.

I have just completed 20 years of service in the highway departments of three separate American states. In these 20 years the expenditures for high class highways in America in the rural districts have grown from possibly as much as two or three million dollars to around three-fourths of a billion dollars. The highway engineering profession has grown from a few dozen men until it is one of the largest employers of engineering talent. There have been great advances made in the field of construction, maintenance and general highway service. The number of motor vehicles has grown from almost nothing to 15,000,000. There are thousands of miles of transits over highways where there was a mile in 1903. The work is changed in every principle and in every detail. Everything has changed. Everything has grown except the attitude of the American people toward the public service.

Until this attitude changes, until there is some rudimentary conception by the great body of our people that this highway enterprise is more than a political pawn to be moved about at will, we will get no effective nationwide highway service, no coherent results, except in the instances where outstanding personalities are in charge of the highway work of states.

Given proper basic laws creating nonpolitical long term highway executives, with reasonable means provided for construction and maintenance, there is no reason why the people of every state should not get quite similar and good results in real traffic service and real transportation economy. Whether the state highway executive is especially brilliant, just the average, or even extremely dull, may vary somewhat the character of the progress but cannot change the basic results. In other words, we want in America a general public conception of the importance of this enterprise and its translation into the field of high class technical study and service, before we will reach our goal of real transportation service.

Unfortunately, it cannot be said that any progress in this direction has been made in the last year or two. At a matter of fact, progress has been quite contrary. Never in the history of the modern road movement have the changes been so many as they have been in the last two years, both in laws and in personnel. It has been the day of the politician and extremist, the experimenter and the vengeful. Many states are paying the price. They will continue to pay the price until they really commence to appreciate the forces they are dealing with.

Statewide highway service is not an accident. It is the result of basic rightness of public thinking translated into legislation possible of producing effective administration and sustained progress.

The foregoing paper was presented by Mr. Hirst at the Tenth Annual Conference on Highway Engineering at the University of Michigan.

OPERATING FEATURES OF THE GARY, INDIANA WATER WORKS

By William Luscombe, Vice-President, Gary Heat, Light and Water Co., Gary, Ind.

About the year 1906 the U. S. Steel Corporation appropriated a huge sum of money for very extensive new and modern mills to be built on a selected site among the Indiana sand dunes along the southern shore of Lake Michigan, which offered many natural advantages.

They also knew that a city of considerable size and magnitude would soon be built in the immediate vicinity to afford

proper housing facilities for their thousands of employees, and one of their first problems in building the City of Gary was to provide an abundant supply of good wholesome water for public and private uses with liberal allowances made in the plans for a fast growing community.

On the town site at that time, there were no substantial buildings and with only waste sand ridges and swamps to view in every direction, it is hardly necessary to add that capital owned by outside interests could not be induced to build a modern water works system, so they set about to do it themselves. Accordingly they employed Messrs. Alvord & Burdick, Hydraulic and Sanitary Engineers, of Chicago, who designed and supervised the construction and installation of the original plant, which included the intake and tunnel, pumping station, pumps, motors, transformers and accessories, also an elevated storage tank, a concrete tower that encloses it and a distribution system that comprised about 22 miles of mains. At that time it was realized water for construction and other purposes would be very much needed in the town site before the permanent intake and tunnel were completed, so a temporary system was installed and afforded a limited supply for about the first two years.

Supply Works

Our water supply is obtained from Lake Michigan through a horseshoe shaped reinforced concrete tunnel of 6 ft. inside diameter. The intake is a submerged crib located about 1½ miles from shore, where good wholesome water is always assured, and in about 44 ft. of water. The crib is octagonal in shape, 6 ft. in diameter, 10 ft. in height, so that the top of the crib is about 34 ft. below the ordinary lake water level.

From the center of this crib, a shaft 10 ft. in diameter was sunk vertically about 50 ft. through some sand into clay, which forms the Lake bed at that point. The tunnel extends on a level southward about three miles and terminates at the bottom of a vertical shaft in the centrally located pumping station just south of 6th Avenue and West of Madison Street or the West Side Park.

The upper one-third of this vertical shaft is enlarged and used as a suction well. Large removable fine meshed wire screens are placed in this well, separating the tunnel opening from the pump suctions, and during a non-pumping period, the water level in this shaft is that of Lake Michigan.

When pumping, the water level is somewhat lower and the pumps operate under from 9 ft. to 12 ft. of suction lift.

The estimated capacity of the tunnel is eighty million gallons per day, which is several times greater than the maximum demand that was ever made upon it and it is expected to be large enough to serve a city of 250,000 population.

The following excerpts from Alvord and Burdick's report relative to the construction of the submerged inlet crib, the tunnel and the necessary shafts may be of some interest.

"It was proposed first to construct the shore shaft near the water's edge of Lake Michigan, and start heading lakeward and landward. It was proposed to construct the inlet crib at South Chicago, together with its superstructure, tow it to the site, sink it, construct a shaft, start the tunnel landward, block up the tunnel, close the lake shaft by means of a plug containing a valve, level with the bottom of the intake crib and then to unfasten the superstructure from the substructure, unbolt the cast iron surplus shaft sections, and remove all structures from the lake bed except the permanent submerged crib. Meanwhile the Lake section of the tunnel would be in progress from the shore shaft, which ultimately would connect with the blind "eye" at the lake intake shaft. This program was adhered to throughout, the only hitch being occasioned by delays in securing a satisfactory shore shaft. It was necessary partially to construct three separate shafts before a satisfactory structure could be secured."

Pumping Machinery

All machinery is driven by electricity furnished by the mammoth power plant of the Illinois Steel Company's Gary Works and the water company's demands represent a very small percent of their capacity output.

The pumping units, originally installed and continued in service, consist of four R. D. Wood & Company's single stage centrifugal pumps, two of which are for general use and the other two more especially for fire purposes, each with a 14-in. suction and a 12-in. discharge, directly driven by separate motors, each of which is 3 phase, 440 volt, 25 cycle, induction type, built by the General Electric Co., and operating at 750 R.P.M.

Each of the two pumps for general use will discharge nine million gallons per

day or eighteen million gallons per day for both under a higher pressure than is ordinarily maintained for domestic use, and in case of fire, the "boosters" or fire pumps may be used to increase the pressure to 100 lbs. or higher, maintaining the full discharge rates when necessary.

To meet the greatly increased demands of a rapidly growing City, during 1920, two additional pumping units of the De Laval make, one for general use and one for fire purposes, each 20 M.G.D. capacity were installed. Also an additional 24-in. force main was laid and connected into the distribution system at a different point so that force mains as well as other important structures are in duplicate.

These two additional units are operated in a similar manner as the original units herein mentioned. Our total pumping capacity output is approximately thirty-eight million gallons per day, which is about double the maximum demands made during any peak load period, so it will be understood we have a large reserve capacity to meet any emergency.

The 1923 maximum daily output was approximately 9,000,000 gals., and the minimum daily quantity pumped was 3½ million gals., the average daily pumpage being approximately 5,000,000 gals. Practically all services are metered.

Fire Stream Capacity

Relative to the works capacity, I might add that during a demonstration made in the month of August, 1921, and staged to determine our ability to furnish sufficient water under the 100 lbs. requirement to extinguish extensive fires and at which time representatives from the National Board of Fire Underwriters, the Indiana Inspection Bureau, also the State Fire Marshal's offices were present, some 28 good effective fire-fighting streams were discharged simultaneously, and in case of necessity we could have doubled that number. This demonstration occurred during a time when a complete survey of the city was being made by the Committee on Fire Prevention and Engineering Standards, representing the National Board of Fire Underwriters.

Some time later when their report was made public, a representative of the Indiana Inspection Bureau stated that the water works systems of Gary and Evansville have the highest rating from a fire protection standpoint of any Indiana cities.

It may be of interest to know the character of service given the city during fires. In 15 seconds after an alarm is sounded the water pressure can be increased and maintained at 100 lbs. or better, which pressure is generally regarded as much higher than the average. Engineers and other authorities from various parts of the country are amazed with this exceptionally good showing, and have reported they have witnessed nothing to equal it.

Dangers in High Pressure for Fire Service

While we are required to about double the domestic pressure whenever an alarm of fire is sounded, and we can readily do so, I regard it as a perilous and impractical undertaking to the city in general, and one which might cause a catastrophe at any time. Such methods have proven very disastrous in many cities and ours may be the next.

Generally speaking, we pride ourselves in handling the more important affairs of life with great skill and dexterity, but the wisdom of some of us in dealing with this matter affecting the public welfare may be seriously questioned when the methods used are fully understood and carefully considered.

For instance it is common knowledge that any structure is most likely to fail or break when subjected to the greatest strain. In many cities and towns the water pressure is greatly increased very frequently, thus producing severe and numerous strains throughout the entire distributing system because a fire alarm is sounded. This crude method is appreciated when statistics prove a very large percentage of such alarms are false, and that a great many fires are extinguished in their incipiency by the use of chemicals, or could be put out by comparatively small quantities of water available at normal pressures, so that in the great majority of instances that the high pressure is applied for fire purposes, it actually serves no useful purpose but really weakens the general water system. Then to cap the climax, we are so illogical as actually to stage practically all of these breaking and failure tests at such times and on such occasions when human life is at stake and property threatened with destruction. Serious failures and breaks naturally occur under such stressed conditions, lives are sometimes sacrificed, property losses are enormous and the story is repeated. Such folly seems incomprehensible.

Use of Portable Pumpers Recommended

It is almost criminal to continue such antiquated, hazardous practices in any

town or city of considerable size, that so places its entire water supply in jeopardy when invariably much better service is insured in a safe and sane modern method by using portable pumpers.

In so far as public fire protection service is concerned, whatever pressure is required to extinguish fires, in excess of that ordinarily furnished for general use, I believe it should be supplied by portable pumpers operated by city fire departments. I believe the universal use of such pumpers is bound to follow sooner or later, and, I believe that Water Departments in those cities and towns where the normal pressure is not to exceed 60 lbs., and the pressure is materially increased during fires, would make a wise investment in the purchase of all public fire hydrants, hereinafter to be installed, equipped with steamer connections, in addition to the usual two-way openings. The distribution mains and hydrant connections should be designed to conform thereto, all in accordance with the specifications of the National Board of Fire Underwriters. This would greatly facilitate matters so that when the change-over was put into effect, much progress toward that end would already have been made.

Our progressive city officials recently placed an order for a powerful 1,000 G.P.M. pumper, and I hope other machines will soon be added to their fire fighting equipment, that we may remove a real menace to life and property.

Chlorination

As has already been mentioned, while the design and location of our intake is especially favorable to obtain pure water at all times, yet as a safety first precaution the water is regularly dosed with liquid chlorine at an average rate of 2 lbs. per each million gallons pumped. This dosage is indeed small as some cities use from four to nine times as much.

Analysis to determine if the water is safe for drinking purposes is regularly made by our own representatives, by the city chemist and by the State Board of Health, so that the public is well protected in this respect.

The speaker has been in charge of the Gary water works properties continuously from the commencement of operations during the year 1907, and has yet to learn of a single case of typhoid caused by drinking the city water. Health officers and others interested who are in a position to know, have held that the few cases of typhoid our city unfortunately is burdened with are due to other causes such as drinking water from shallow wells, so called "imported cases," etc.

Statistics show we have the lowest typhoid death rate of any city in the Calumet region. With a continued betterment in sanitary conditions each year, a better record is being made.

Gary is Growing Up

Gary has a frontage of about twelve miles on Lake Michigan. Within the city limits the area is about 40 sq. miles, and the population is now 75,000 and the yearly rate of increase is placed at 18 percent. Large additions have recently been made to the mammoth mills, and considering our new industries, the 100,000 mark will be passed within a few years.

A total of 500 acres has been dedicated for park purposes. During the last two years a half million dollars was expended on buildings, grounds, etc., in improving and beautifying a 130 acre Lake Front Park, which is visited by thousands of Chicagoans as well as a large percentage of the population throughout the Calumet district.

Distribution System

The distribution system including several miles serving the old town of Millers, now comprises about 90 miles of mains ranging in size from 6-in., to 30-in., and provide a water supply for approximately 90 percent of our population, or about 67,500 people.

Mains are extended when there is a reasonable demand or the gross annual revenue equals 10 percent of the improvement cost. In a number of recent instances, field investigations disclosed the fact there was not then sufficient new business available from buildings already erected or under construction along the proposed lines to equal the 10 percent. In such cases and in order to make the extensions possible, the subdivision owners, or a large property owner, entered into a contract with our company, agreeing to pay us the difference between ten percent on the cost of such new extension, and the entire gross revenue received by the Water Company from takers of water through such new extension during such year, until such time as the entire gross revenue received from takers of water through such new extension equals and amounts to the 10 percent. Any revenue received from the city for public fire hy-

drant rental is credited to the 10 percent referred to.

These parties and others have proven it a good investment and good business to make such contracts as it results in enhancing the value of unimproved property increases the number of their sales because there is a much better demand for property adjacent to water mains and oftentimes the amount the guarantor is called upon to pay is so small as to be negligible.

Ordinarily in most cities property owners pay for the water service pipe from the main line. However, where properties are adjacent to the main, and most of them are, we make the tap, furnish, install and maintain the service pipe from the main to the property line at our own expense. This represents a considerable saving to property owners, and we trust is appreciated.

The foregoing paper by Mr. Luscombe was presented at the recent annual meeting of the Indiana Sanitary and Water Supply Association.

LIMITATIONS OF BITUMINOUS SURFACE TREATMENTS AND BITUMINOUS MACADAM PAVEMENTS UNDER MODERN TRAFFIC

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Treatment of this subject in a concise and comprehensive manner is made rather difficult because of the fact that there appears to be insufficient standardization in the construction and maintenance of surfacers of these types. In certain isolated localities, of course, both selection of materials and methods of construction and maintenance have been standardized more or less as a result of local experiment, but we fail to find sound, uniform practice developed as a result of intensive scientific research and adopted generally throughout the United States.

Standardization is Lacking

Not only is standardization in practice lacking, but there appears to be a decided lack of a well-developed technique surrounding the construction and maintenance of both types of roads involved by this topic. It would appear perhaps that the widespread demand for higher types of surfaces has resulted in concentration of technical effort upon solution of the many problems involved by the higher types, to the detriment of the less expensive types. In studying the written information pertaining to these surfaces one must be impressed by the facts that many of the fundamentals of both types of surfaces have not been studied intensively and that a sufficient amount of research has not been devoted to roads of these types. The comparatively sound practice of building or of maintaining these roads which is found locally well may be considered to exemplify the need for intensive scientific study aimed to eliminate the many indeterminates encountered by the engineer in his attempt to solve the problems incident to establishing a rational practice controlling these types.

A third feature which tends to make it difficult for a student of this subject to arrive at definite conclusions is the tendency in many localities to replace surfaces of both types by more expensive surfaces, not always perhaps with due regard to the securing of the ultimate economical life from the cheaper types. Popular enthusiasm for good roads in some localities seems to have resulted in popular disapproval of types of surfaces of the so-called cheaper classes.

Results Secured Not Uniform

In studying bituminous surface treatments and bituminous macadam pavements in the United States, one is particularly impressed by the lack of uniformity in results secured. This fact of course tends to prove the previous contention that there has been no well-developed technique advanced for the construction and maintenance of these types of surfaces. In certain localities we find almost complete failure attending attempts to maintain economically under modern traffic surfaces of both types. In close proximity to these localities frequently we find marked success attending the maintenance under modern traffic of one or both of these types of surfaces. It is believed by the writer that there are no other types of surfaces which have produced more variable results under modern traffic than have the two types covered by this paper.

More Study Needed

It has been alleged, and perhaps rightly, that the scientific thought devoted to bituminous surface treatments and to bituminous macadam during recent years has retrogressed rather than advanced. The use of bitumens for surface treat-

ments and for binders in the construction of bituminous macadam pavements were among the first methods adopted by highway engineers in the neighborhood of fifteen years ago in their attempt to stem the tide of disaster which threatened existing road surfaces at that time as a result of the inception of motor vehicle traffic. At that time and for several years thereafter a great deal of study was devoted to the problem incident to the use of bitumens in the manners referred to. Later, it appears that less and less study has been devoted to these types, so we are unable to point to a great deal of recent innovation in the technique surrounding the construction and maintenance of these types of surfaces.

The aim of the writer in treatment of this subject, first, is to discuss the service rendered by both types of surfaces under modern traffic and, second, to point out certain unfortunate circumstances surrounding the construction and maintenance of these surfaces which perhaps may account for the extremely variable results which are so apparent.

Bituminous Surface Treatments

Bituminous surface treatments are applied to many types of road. Earth, sand-clay, gravel and macadam are some of the surfacing materials to which bitumen is applied extensively. Surface treatments also are applied to roads of each type which are in variable condition and which are surfaced with materials far from uniform in quality. It would appear, therefore, that a discussion of the limitations of bituminous surface treatments necessarily must include a discussion of the influence of various types of roads in various conditions upon the probable success of surface treatments.

It may be questioned seriously if sufficent attention has been devoted to the problem of correlating surface treatment to the type and condition of the road. A great deal of the written matter pertaining to this subject has to do primarily with the virtue of bituminous materials of various types employed for surface treatment. It is very apparent that the character of surfaces to be treated has a very decided influence upon the results obtained from surface treatment with bitumens. In view of the tremendous amount of bituminous surface treatment accomplished annually in the United States it would appear perhaps that there is a decided need for research aimed to eliminate some of the many indeterminates encountered by engineers in this particular phase of work, especially in regard to the correlation of the material to the character and condition of the road.

Best Field for Bituminous Surface Treatments

Bituminous surface treatments in general appear to be more effective when applied to surfaces consisting in large part of coarse, granular material. A large percentage of fine particles in the material composing a road does not appear to be conducive to the success of bituminous surface treatment. It is a matter of common knowledge, of course, that the surface treatment with bitumen of earth roads and sand-clay roads ordinarily does not produce excellent results. Except upon the ground of expediency, therefore, it is doubtful if bituminous surface treatment should be applied to roads of these types. As compared with other methods of maintenance, it is doubtful if treatment of earth and sand-clay roads with bitumen adds sufficiently to the service of such roads to justify the expense. This is particularly true in the North where the effect of frost very frequently is serious upon roads of these types, provided they carry a considerable amount of traffic during the spring thaws.

Gravel roads have been surface-treated with bitumen successfully for many years. Observation of results secured from bituminous surface treatment of gravel roads appears to justify the statement that the character of the gravel has a great deal to do with the success of surface treatment and should have a great deal to do with the selection of the material for surface treatment. Some of the so-called natural road building gravels, containing a considerable amount of fine material which serves as a binder, do not respond well to treatments with certain bituminous materials which give excellent results when applied to coarse gravel, which demands wetting and rolling in order to secure proper consolidation.

New England Experience

In New England, where State road building began at a very early date, some of the State highway systems were surfaced originally in considerable part with gravel. Funds have not been forthcoming in sufficient amount to replace these surfaces as the traffic has increased. We find in New England, therefore, a large mileage of gravel surfaces subjected to fairly heavy traffic.

Experience in New England appears to indicate that, aside from the dust nuisance, an untreated gravel road may carry successfully and economically a traffic as great as 500 vehicles per day. If traffic of several thousand vehicles per day passes over gravel roads, the experience in New England appears to indicate that surface treatment is advisable. There is to be found in New England a considerable mileage of gravel roads, surface-treated with bitumen, which carries between 2,000 and 2,500 vehicles per day during about seven months of the year, at a total cost of maintenance of approximately $1,400 per mile per year. These roads, in large part, render an excellent service to traffic, and there appears to be no well-founded objections to these roads except perhaps upon the ground of their high cost of maintenance.

Considerations of Economy

In discussing the economy of these roads we must consider first, that the building of the roads, involving as it did a comparatively low initial cost, has provided facilities for traffic far greater than could have been provided if more expensive types only had been selected. In a great many cases also the annual cost of maintenance is no greater than the annual interest upon the investment for some of the more expensive types of surfaces plus the annual maintenance cost of the more expensive types. A study of economy, of course, is incomplete without consideration of the service rendered by the roads. Well-maintained gravel surfaces are popular with the motoring public in a considerable portion of New England, simply because these roads are maintained in good condition at all times. There appears to be insufficient ground for criticism, therefore, that the service rendered by gravel roads in New England in general is not economical.

Effects of Truck Traffic

In some localities in New England it has been noted that truck traffic is decidedly detrimental to gravel roads surface-treated with bitumen. This appears to be especially true during the spring thaws, when the roads, of course, are in their weakest condition. In the cases of roads carrying between 2,000 and 2,500 vehicles per day, therefore, it may be questioned if economical service from gravel roads will follow if truck traffic constitutes a large percentage of the total traffic. Definite information permitting an accurate estimate of the amount of truck traffic which a gravel road will stand successfully appears to be lacking. It is the opinion of a number of New England engineers, however, that a percentage of truck traffic to the total traffic in excess of 5 percent causes considerable injury to surface-treated gravel roads subjected to a total traffic of from 2,000 to 2,500 vehicles per day.

Effects of Frost

Since the alleged inability of gravel roads to stand up under the combined effects of traffic and of frost action sometimes is considered to be the limiting feature of the service rendered by gravel roads, the effect of frost perhaps is worthy of special mention. We observe frequently gravel roads subjected to traffic throughout the entire year which appear to be affected by frost to a negligible degree, and we observe upon the other hand instances of serious rutting and heaving of gravel roads, both untreated and treated with bitumen. Excessive destructive effect of frost action upon gravel roads in many cases, of course, may be attributed directly to peculiarities of the subsoil below the gravel surface. In some cases, however, it appears reasonable to presume that the type of gravel has a considerable influence upon the effect of frost.

Excess of fine material in the gravel without doubt tends to promote capillarity in the gravel, and tends thereby to intensify the effect of frost action within the layer of gravel. It would appear, therefore, that a study of gravel suitable for use in the construction of gravel roads should include a study of the capillarity of the material. In some sections the separate deposits of gravel available for road building are very uniform in character. In other sections, however, gravel is extremely variable in character, permitting selection of the better qualities. Excessive frost action, of course, may be so serious in its effect upon the service rendered by gravel roads that it appears to be worth while to do more than is done generally to attempt to eliminate frost action so far as is economical and practicable.

Although we find instances of traffic over gravel roads in amount exceeding 2,500 vehicles per day, it is doubtful if surface-treated gravel is economical for traffic any greater. It is true, of course, that some types of gravel cannot carry economically when surface-treated with

bitumen a traffic as great as 2,500 vehicles per day.

Selection of Gravel

The lack of uniformity in results obtained from the surface treatments of gravel provides an almost insurmountable obstacle to a successful attempt to state specifically how much traffic roads of this type can carry successfully. It may be questioned if the features influencing the selection of gravel for the construction of gravel roads perhaps have not, in usual practice, been confined to the features productive of the best results untreated. There appears to be some reason to doubt whether or not the best results from bituminous surface treatment of gravel roads follow from the use of gravel in the construction of the road which gives the best results untreated. This feature is believed to be worthy of a more intensive study than yet appears to have been made of it.

Surface Treatment of Macadam Roads

Surface treatment of macadam roads offers a problem somewhat different from the problem of surface treatment of the types mentioned previously. A macadam surface ordinarily is more readily freed from fine particles interfering with the success of surface treatment, and the structure of a macadam road also is more rigid than the structures of the types mentioned previously, except perhaps the better class of gravel roads. Surface treatment of macadam roads, of course, is a practice which has been in vogue in municipalities and upon State highway systems for a long time. Macadam surfaces appear to lend themselves to treatment with heavy materials more readily than do the types mentioned previously. In some sections the success attending the surface treatment of macadam surfaces with bitumen, considerably heavier than ordinarily is considered suitable for work of this class, provides a very interesting study.

Value of Priming Coat

The value of a so-called priming coat, employed initially upon macadam surfaces which have not been surface-treated with bitumen previously, also is an interesting phase of the problem of surface treating macadam roads. Unusually good results appear to have followed from the use of a light priming coat, followed after a few weeks by a heavy material which well could not be used for the initial application. The use of the heavier materials at intervals of several years rather than the use of lighter materials each year, with the exception perhaps of one year in three, perhaps is worthy of greater study than yet has been devoted to it.

As in the case of gravel roads, we find that results from bituminous surface treatment of macadam roads vary greatly. In southern New England comprehensive systems of state roads were built during the period in which macadam roads were considered to be the best roads possible to build in rural sections. The problem of maintaining these roads, many of which were built before the beginning of the present century, has been a difficult problem to solve. Surface-treated macadam roads have given very good service in southern New England at a cost in the neighborhood of $1,200 per mile per year under traffic between 2,500 and 3,000 vehicles per day during seven months of each year.

In the case of macadam roads, resurfacing with a higher type of top is not as expensive an undertaking as is the case with the types of surfaces mentioned previously. For that reason, perhaps, it may be questioned if it is economy to surface treat gravel roads carrying a traffic in excess of 2,000 vehicles per day, unless it is financially impossible to resurface them.

Macadam roads, of course, also are affected by frost action, especially when they are called upon to carry a fairly heavy traffic during the spring thaws. The effect of frost action upon a macadam road should be considered in planning the surface treatment. The better classes of surface treatment very well may be considered out of order in the case of macadam roads which are seriously affected by frost action, simply because the surfaces inevitably will be destroyed during the spring months. If it is impossible to carry out preventive measures aimed to eliminate frost action, therefore, it is believed the cheaper treatments are more economical in the end.

Surface treatment of some of the higher types of bituminous pavements, of course, is a maintenance measure. The surface treatment of bituminous macadam roads is considered later in this paper.

Surface Treatment of Bituminous Concretes

The surface treatment of bituminous concretes is resorted to periodically as a method of restoring the surface. This class of work, within the scope of this

topic, apparently should be limited only to a discussion of the efficacy of surface treatment of bituminous concrete pavements as compared with the plan of eliminating surface treatments and resurfacing or completely replacing the bituminous concrete surface when the wear necessitates it. Judicious surface treatment of bituminous concrete pavements appears to place the pavement in substantially as good condition as it was originally, unless of course there is some fundamental fault inherent to the pavement. Perhaps, therefore, we are justified in stating that the traffic limitations of a surface treatment applied to bituminous concrete pavements is identical with the traffic limitations of that class of pavement.

Bituminous Macadam

The practice of constructing and maintaining bituminous macadam pavements is extremely variable. In discussing pavements of this type, therefore, we must not presume that we are discussing a type of pavement which is standardized in construction and in maintenance to the extent which many of the higher types are standardized. We find numerous instances of dismal failure of bituminous macadam pavements under comparatively light traffic. Upon the other hand, we find certain instances of the rendering of very economical service of pavements of this class under heavy traffic. In connection with a discussion of the traffic limitations of this class of pavement, therefore, the lack of standardization and the lack of uniformity in results secured present difficult problems.

Our results with bituminous macadam in Rhode Island fail to disclose any definite relationship between volume of traffic and cost of maintenance. This would appear to indicate, of course, that features of design, construction and maintenance are of tremendous importance so far as service rendered by the pavements is concerned. In our attempt to determine the limitations of bituminous macadam upon our State highway system in Rhode Island, very frequently we are confronted by paradoxes such as the lowest maintenance costs upon the projects carrying the greatest traffic. This study, however, leads us to the conclusion that bituminous macadam pavements are capable of standing very heavy traffic, provided an intensive study of these pavements succeeds in eliminating a number of very common faults both in connection with construction and in connection with maintenance. We are at a loss to account many times for the paradoxes in our experience of the type referred to previously.

The accompanying table of costs of Rhode Island bituminous macadam pavements is of interest.

Two of the sections built in 1913 were resurfacing projects over old macadam. These sections were replaced during 1923. Except for this replacement of two very cheap jobs, all of our bituminous macadam is carrying traffic successfully.

Progressive corrugation of the surfaces of bituminous macadam is considered by some to be the most serious feature limiting the service rendered by these pavements. It is true, of course, that this fault is very much in evidence in many sections. This fault, however, is believed not to be inherent to pavements of this class, but due rather to unfortunate selection of materials or to unfortunate features incident to construction. The matter of elimination of progressive corrugation is not considered to be within the scope of this paper, but it is a matter having a great deal to do with the limitation of bituminous macadam pavements under modern traffic and is therefore a subject deserving of careful study.

Traffic Borne in Rhode Island

The bituminous macadam pavements upon the State highway system of Rhode Island are called upon to carry traffic varying from approximately 1,000 vehicles of all classes per day to traffic of approximately 7,000 vehicles of all classes per day during seven months of each

COST DATA ON RHODE ISLAND BITUMINOUS MACADAM PAVEMENTS.

Year of Construction	Prevailing Width of Pavement	Average Cost of Pavement per Mile*	Average Maintenance Cost per Mile of Pavemeint per Year Since Construction**
1913	14 ft.	$ 7,660.27	$153.35
1915	18 ft.	8,417.65	112.82
1916	18 ft.	12,067.83	217.01
1917	18 ft.	17,207.83	186.85
1918	18 ft.	18,333.53	114.35
1919	18 ft.	18,616.07	103.04
1920	18 ft.	23,730.64	31.33

*Cost of pavement only, exclusive of costs of grading, foundations and drainage.
**Cost of maintenance of pavement only.

year. Since our State is primarily industrial throughout and since our population is dense, the traffic over our roads, of course, is heavy during the winter months. Snow removal upon all State roads is considered in our State to be absolutely essential and is carried out. Of this total traffic motor trucks here constitute from 200 to 600 vehicles per day, and this traffic varies little with the seasons.

Importance of Refinement of Method

As an indication that refinement of method of construction and maintenance perhaps is of the greatest importance in the case of bituminous macadam pavements, it is interesting to note the cost of maintenance of the projects completed during very recent years with the costs of maintenance of the projects completed previously. For three years following 1916 the bituminous macadam pavements constructed during that year cost an average of $77.50 per mile per year for maintenance. The projects constructed during 1920 cost, during the following three years, for maintenance, an average of $31.33 per mile per year. Traffic over the State roads of Rhode Island, of course, increased greatly during the period from 1916 to 1920, and this illustration is offered of the possibilities afforded for the development of rational methods of construction of bituminous macadam pavements to the end that the very common faults of these pavements may be eliminated. The lower maintenance costs of the projects completed in 1920, we believe, is attributable only to greater care in connection with the innumerable details of construction.

Faulty Maintenance Methods

Questionable methods of maintenance also, we believe, account for a great deal of variation in results secured from the use of bituminous macadam pavements. It is the practice in Rhode Island to reduce the number of resealing operations to a minimum. Progressive corrugation of bituminous macadam pavements, we believe, is stimulated greatly by the application of excess of bitumen upon the surface. In our practice of maintenance, therefore, local resealing only is resorted to until a large percentage of the total area displays evidence of a need for resealing. Several of the projects constructed in 1913 yet have not been resealed except locally. Under our plan of maintenance of bituminous macadam pavements the materials and methods employed in original construction are adhered to strictly. This practice is followed because of our belief that it promotes the preservation of uniformity of the surface and thereby adds to the economical life of the pavement. We do not favor any plan of maintenance which tends toward lack of uniformity of surface.

Apparently we must consider that resealing of bituminous macadam surfaces is a necessity sooner or later. In planning such surface treatments, however, it appears that the greatest care must be taken, both in regard to selection of materials and in regard to the methods and amounts of application. Surface treatment of bituminous macadam pavements, judiciously carried out, appears to restore these pavements to their original condition very effectively.

Foundation Treatment

Foundation weakness many times limits directly the service rendered by bituminous macadam pavements. The structural strength of such pavements is negligible, so it cannot be presumed that the pavements are capable of carrying traffic successfully over unstable subsoil without careful attention to the foundation problem. It is true, however, that these pavements are capable of withstanding without apparent serious damage considerable distortion due to frost action. For that reason it does not appear to be necessary in the design absolutely to eliminate all effect of frost action upon the pavement. So-called insulating layers of permeable material directly below the pavement have been found to be very effective over heavy, retentive subsoil.

The Binder

It appears also to be essential to make a careful study of the problem of the correlation of the binder to the quality of crushed stone. Binders which produce excellent results with certain rock give mediocre or even poor results when combined with other types of rock. Research into this phase of bituminous macadam pavements perhaps would result in the elimination of much of the variation in results secured at present.

So far as our results in Rhode Island are concerned, it appears that bituminous macadam pavements 18-ft. or 20-ft. in width will render economical service when subjected to traffic in excess of 5,000 vehicles per day. In order for pavements to carry that amount of traffic successfully, however, more attention to the

details of design, construction and maintenance is necessary than is given in usual practice.

The foregoing paper, by Mr. Patterson, was presented at the Tenth Annual Conference on Highway Engineering, recently held at the University of Michigan, at Ann Arbor.

THE TENDENCY TOWARD CENTRALIZATION OF POWER DEVELOPMENT

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All United States is divided into four parts—East, South, West and Middle West.

To locate the boundaries of these parts to the satisfaction of all concerned would require the services of a board of arbitration. But, with violence to and disregard for the opinions of others, I have, for the purpose of this paper, which deals only with the Middle West, included in that part Western Pennsylvania and Eastern Kansas, and everything from the southern borders of Missouri and Kentucky north to the Great Lakes and the Canadian border.

It is a great empire, comprising 66,000 square miles and having a population of 40,000,000 inhabitants. It all lies in the Mississippi Valley, and scarcely 1 per cent of it can be rated as mountainous, its broad stretches of prairie and forest lands having in general such slight declivity and absorbent soil that the water run-off, excepting that lost in floods, does not exceed one-fifth of the precipitation, and its placid streams for the greater part of their courses flow to the lakes or sea with a slope of half a foot to the mile.

Such a gentle fall of course makes possible relatively little water power, considering the length and breadth of the streams, but as compensation, because these streams have not eroded the soil, the prairie states, with their unrivaled fertility, will some day support a teeming population of hundreds of millions, whose increasing clamor for power must be satisfied principally, as now, by coal drawn from their own great stores.

What Various States Are Doing

Fig. 1, adapted from a similar illustration which appeared a few years ago in the "Electrical World," is an ingenious redistribution of the map area of the country, designed to show up the various states in their electrical importance as was the situation about a year ago. This map, which represents relative kilowatt hour production, is doubtless a fairly accurate relative representation of the installed kilowatt hour capacity in the whole country. In this classification, as in many others, New York stands at the

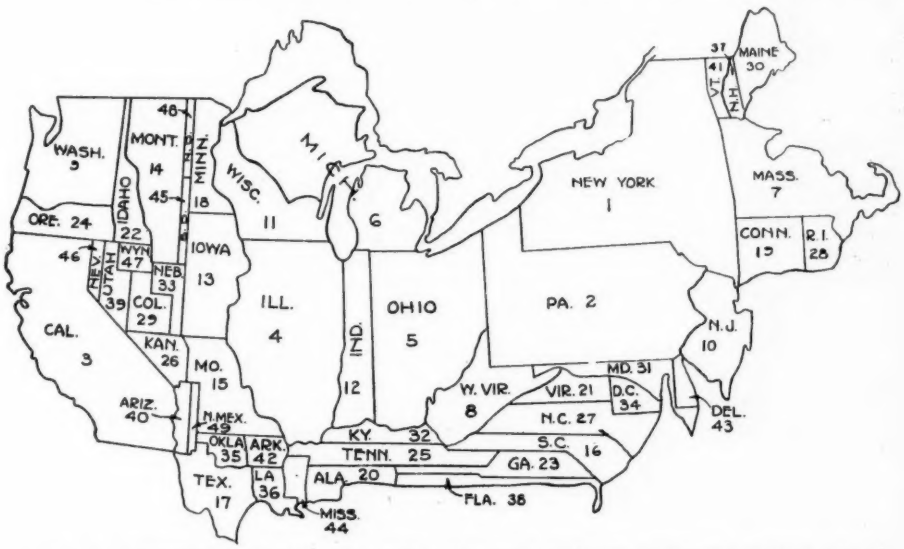

FIG. 1—REDISTRIBUTION OF AREA OF THE UNITED STATES ACCORDING TO ELECTRICAL IMPORTANCE.
The Map Shows Relative Kilowatt Hour Production.

head with 40 per cent of its output coming from its water powers, principally those at Niagara. Next in order comes Pennsylvania; then California, 80 per cent of whose electrical output is generated by water power from its impounded mountain streams. Illinois is fourth, 95 per cent of its output coming from coal. Ohio is fifth, 99 per cent from coal; Michigan, sixth, 32 per cent of its output from water. West Virginia, a mountainous state, is ninth, with only 2 per cent of its output from water power, and Kentucky, also a mountainous coal state, has as yet developed practically no water power. Idaho and Montana, along in the middle of the list, get less than 1 per cent of their power from burning fuel.

Development of Electric Lighting Industry

The development of the electric lighting industry has been pretty much the same in all communities—originally some individual installed a small isolated plant for his own service; later, as an accommodation, he extended that service to neighbors. In time a number of these lighting systems were consolidated as a central station and became a separate business. Two or more of these stations, as neighbors, would become so violently competitive that consolidation was inevitable to prevent destruction.

Consolidation on the Increase

This process of enlarging and consolidating has continued ever since and is still continuing. Few, if any, large cities now have more than one lighting company, and the lighting business of neighboring towns and smaller cities is being grouped into vast systems, whose transmission lines cross state lines and, being supplied with power from large and efficient plants located at strategic points, render a service whose dependability and cheapness could not possibly be approached by the smaller systems which were consolidated to make the larger ones. Evidence of this fact is given by the coal mines, which no longer can afford to generate their own power with their own slack, but instead are taking it from high voltage transmission lines fed from some distant power house, which burns perhaps the screenings from the same mines, with its original cost increased by a freight charge.

Power Consolidation Reduces Fuel Demand

In this connection it would be of interest to trace how this consolidation of power has reduced the fuel demand. Originally a manufacturer installed a dynamo driven from a belt off the main shaft, a hand-fired boiler and plain slide-valve engine for prime mover, usually operating at about half capacity, and of that amount of power probably one-half was lost in friction. Under such conditions, 20 lbs. of coal per kilowatt hour would be fair. The next step was to install a high-speed engine of 100 H. P., driving belted generators, which would in a day's run—full load and light load—produce a kilowatt hour on say 15 lbs. of coal. The next step was the consolidation of two or more of these isolated central stations into a group, supplied with power from the best and best-located plant of the group. It was found that with an improved load factor and larger units, the coal consumption was reduced to 10 lbs. per kilowatt hour. The next step was to connect these groups into larger ones of 5,000 kilowatt capacity, favorably located as regards condensing water and rail connections, having compound condensing engines and capable of delivering a unit of energy for 6 lbs. of coal, and when turbines were substituted for the reciprocating engines the coal consumption dropped to 4 lbs. A plant of this size can reach out its arms and gather in all the business within a radius of 30 miles or so.

Connecting Middle West Plants.

This was about the most efficient combination of station power and transmission lines, unless it happened that the power demands of the city in which the plant was located were such that the use of turbines up to 10,000 kilowatt capacity was practicable, in which case the efficiency was further improved to 3 lbs., warranting the construction of still longer lines to reach more remote localities. But the process of consolidation is not stopping there. The tendency now is to connect all of the power of the Middle West into plants having a capacity of 40,000 kilowatts or more and an efficiency of 2 lbs. of coal per kilowatt hour. This is brought about by the development of higher tension transmission, by the increasing density of power all over the country, and by the increasing cost of fuel, which in many cases renders the cost of power prohibitive when generated in small quantities.

Little Water Power in Middle West

It is frequently remarked that the

Middle West is under great handicap because it has so little water power. It is even suggested that hydro power from the Rocky Mountains, more than a thousand miles distant, be transmitted here on high tension lines to conserve our coal and lower the cost of power.

This proposition, although interesting and having some elements of plausibility when considered in the light of what the mountain states are themselves doing with this power, is, upon analysis, wholly absurd, as it is unable to compete in price with power generated with coal from our own coal fields. It is also suggested that the power plants be located at the mine and the power sent from thence to the remote center, where it is principally to be used, thus saving the cost of the railway haul. But for some reason this is not done in any large way, the obvious explanation being that with summer temperatures, 500 lbs. of circulating water are required for each pound of coal burned, and with a plant developing 50,000 kilowatts there would be required in the neighborhood of 200 cubic feet of water a second for condensation, and streams of that flow in summer rarely abound on the prairies near coal mines, while the cost per kilowatt of a transmission line for a plant of less capacity would be prohibitive.

It is true that a smaller supply of condensing water might serve such a plant if cooling towers or a cooling pond were used, but if the heat of 60 tons of coal be used each hour principally to warm up the water in such a pond, its temperature would be bound to go far above that of the atmosphere, with material reduction of plant efficiency and capacity.

Rail Transmission of Power Still Cheaper Than Wire Transmission

This is the obvious and usual reason given why steam electric power is not developed in quantity at the mines and transmitted long distances by wire, and while this answer is usually correct and sufficient, it is not always so, as there are many places where coal is produced on the banks of rivers, and yet the coal leaves the mines by rail for power plants 100, 200 or 300 miles away. We are, therefore, forced to the conclusion that rail transmission of power in large quantities is still cheaper than wire transmission, and, curiously enough, the greater the distance the less advantageous becomes electric transmission.

Illustrative Problem

To illustrate, assume a water power capable of generating 100,000 kilowatts and a coal mine, each 100 miles from a large market for power. Assume also that a steam-electric plant can be built for $120 a kilowatt of capacity, and that the water power can be developed at a cost of $200 per kilowatt; a high voltage double-tower line of two circuits each will cost $35,000 a mile; coal can be bought at the mine for $2.25 a ton, and that a kilowatt hour can be generated on 1.8 lbs. of coal, load factor 75 per cent and transmission losses 1 per cent for each 20 miles. While we are about it, let's also see what the relations would be at 200 miles and at 300 miles.

Problem: Shall we (a) develop the water power and transmit the energy; (b) build the steam plant at the coal mine and transmit, or (c) build a steam plant where the power is to be used and ship the coal to it from the mine?

How Railroad Coal Freight Schedules Are Made Up

Right here it might be interesting to railroad men to have a layman explain the system by which railroad coal freight schedules are made up. I do not know that there really is a system by which these schedules are constructed, but here is a rule that will loosely fit most of them in this locality: A charge of four-tenths of a cent a ton mile, plus a base rate of $1.00 a ton.

For example, from Braidwood to Chicago is 57 miles; multiplying by 0.4 cts. gives 23 cts.; adding the base rate of $1.00 gives $1.23. The actual rate is $1.48. From Danville to Chicago is 123 miles. This, by the formula, should be $1.49; the rate is $1.55. Springfield, 185 miles away, should have a rate of $1.74; it is $1.65. Harrisburg, 306 miles distant, should have a rate of $2.24; it is $2.16. Applying this freight rate formula to the problem above stated, we obtain the results given in Table I.

From Table I it appears that, with coal at prevailing prices in this territory, water power within 200 miles of the place where its power can be used has some intrinsic value as such, but beyond that distance it had better be developed for its scenic value; while in case of a power plant at the mine mouth and with an abundance of condensing water at hand, it, too, would be outclassed by a power house supplied by rail-borne coal, located in the big city 100 miles or more

TABLE I

	Hydro	Steam at Mine	Steam in City
100-Mile Line:			
Cost of Power Plant	$21,000,000	$12,600,000	$12,000,000
Cost of Line	3,675,000	3,675,000	.....
Total	$24,675,000	$16,275,000	$12,000,000
Overhead at 12%	$ 3,000,000	$ 1,853,000	$ 1,440,000
Tons Coal Burned	.....	(622,999)	(592,000)
Mine Cost	.....	1,400,000	1,332,000
Freight	.....	.....	829,000
	$ 3,000,000	$ 3,253,000	$ 3,691,000
200-Mile Line:			
Cost of Power Plant	$22,000,000	$13,200,000	$12,000,000
Cost of Line	7,350,000	7,350,000	.....
Total	$29,350,000	$20,550,000	$12,000,000
Overhead at 12%	$ 3,532,000	$ 2,466,000	$ 1,440,000
Tons Coal Burned	.....	(651,000)	(592,000)
Mine Cost	.....	1,465,000	1,332,000
Freight	.....	.....	1,172,000
	$ 3,532,000	$ 3,931,000	$ 3,944,000
300-Mile Line:			
Cost of Power Plant	$23,000,000	$13,800,000	$12,000,000
Cost of Line	11,025,000	11,025,000	.....
Total	$34,025,000	$24,825,000	$12,000,000
Overhead at 12%	$ 4,080,000	$ 2,980,000	$ 1,440,000
Tons Coal Burned	.....	(681,000)	(592,000)
Mine Cost	.....	1,532,000	1,332,000
Freight	.....	.....	1,302,000
	$ 4,080,000	$ 4,512,000	$ 4,074,000

distant where the power is to be used.

This estimate is based on using a double-tower line of two circuits each on a private right-of-way with the best modern construction, designed to carry at 75 per cent load factor the 100,000 kilowatt base of a load that would amount to 350,000 kilowatts.

If the hydro plant or the steam plant at the mine were obliged to carry enough of the load to reduce its load factor to 50 per cent, it is probable that all three would be on about the same basis at 100 miles, and beyond that distance the plants operating over transmission lines would begin to fall behind the plant located near the place where its power is to be used.

It is nevertheless true that some water powers near coal mines are being developed, but it is also true that in most cases such developments are economic errors, and it is often being done because an undeveloped water power is a menace to the local power company if it is left undeveloped. Not because some potential rival could make money by the development, but because he might not know that he could not.

Fig. 2 is a map showing the distribution lines of the territory discussed, and also showing by dots and circles the centers where the power is generated and used. The smallest circle shown represents 500 kilowatts. Smaller amounts of power are indicated by dots. Central power stations of less than 500 kilowatts and not connected up to another center do not appear on the map. The developed central station power of this territory is 4,800,000 kilowatts. Two or more towns connected by transmission lines indicate a consolidation or at least a federation of interests.

The lines and circles on the map show with remarkable distinctness, as would be expected, the manufacturing centers and the districts of greatest population, beginning at Pittsburgh on the east, following along the lakes to Detroit, and then across the lower Michigan peninsula, through a number of flourishing manufacturing towns, down to the south end of Lake Michigan, where the various power plants of the Commonwealth Edison Company are shown in the area of one grand circle, which is the dominating feature of the whole map. Within the circle, but not included in its area, are circles denoting various other power houses in the Chicago district, but outside of Chicago proper.

Farther north is a circle which includes the combined power of Milwaukee and Racine, together with some energy received over a high tension line from

the water power development on the Wisconsin River at Kilbourn and Prairie du Sac. Farther northwest is a larger circle, denoting the power of Minneapolis, and a smaller one within the larger, showing the generating capacity in St. Paul, and north and east is the combined power of Duluth and West Superior, with something fed in over a transmission line from water powers farther northwest.

Going down the Mississippi River, the first development of any consequence is that of the tri-cities—Davenport, Moline and Rock Island, and farther down is the Keokuk water power, shown by a broken circle. The greater part of this power is sent to St. Louis over a 110,000-volt transmission line, and is included in the area surrounding that city. The circle showing the installed generating capacity at Kansas City, Mo., surrounds the circle indicating the power installed at Kansas City, Kan.; Joplin, Mo., and Wichita, Kan., are features in the southwest corner of the map. In Indiana, Indianapolis, New Albany and Fort Wayne are the cities using most power. In Ohio power is more evenly distributed among its numerous thriving manufacturing cities than in any other state. All over Ohio, Indiana, Michigan and Iowa, and, to a lesser extent, Wisconsin and Minnesota, the small towns and villages are connected together on tie lines of less than 40,000 volts, and fed from some centrally located power system in one of the larger towns.

Of this whole territory, about one-sixth of the power is hydraulic and five-sixths steam, the largest single water power being that at Keokuk, which is something over 100,000 kilowatts. The next largest series of water powers is in the Southern Michigan peninsula, aggregating 86,000 k. w., located on water powers along the Au Sable, Manistee and Grand shed running the length of the southern peninsula and having an elevation of 500 ft. above the lakes. This water power

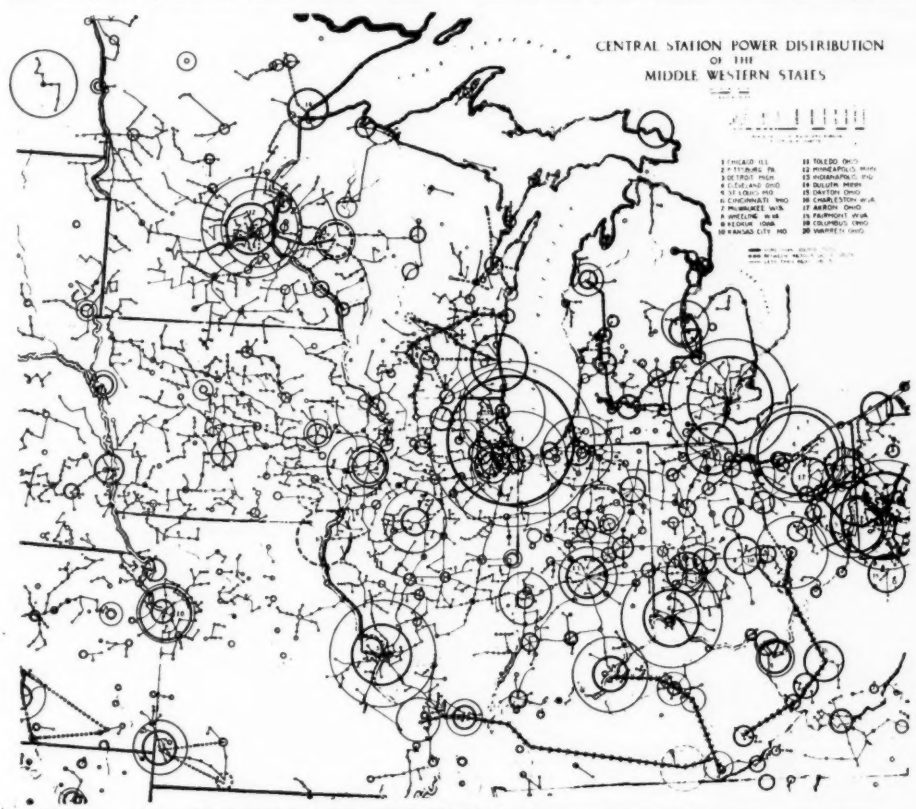

FIG. 2—MAP SHOWING THE ELECTRICAL DISTRIBUTION LINES OF THE MIDDLE WEST.

Dots and Circles Show Centers Where Power is Generated and Used. Central Stations of Less Than 500 K. W. and Not Connected to Another Center are Not Shown Here.

is supplemented by 114,000 kilowatts of steam.

The northern part of Wisconsin has an elevation of some 1,200 to 1,500 ft. above sea level, while the Mississippi River along the Wisconsin border has an elevation of from 600 to 700 ft. Therefore, the Wisconsin rivers which discharge into the Mississippi have a fall of 500 to 800 ft. in their short, turbulent courses, affording many opportunities for the development of water power. Some such developments are indicated on the Wisconsin and the Chippewa, and other developments are under construction or consideration.

A map like this can never be correct. It was supposed to represent the situation at the beginning of 1923, but obviously many developments, being in all stages of completion, were not reported the same way, and the period since the information was gathered has been the greatest of all time for the installation of electric generating capacity. The circles in heavy lines represent the situation as it was a year ago; the circles of lighter lines represent subsequent power house development—some already finished, some now under construction, and some on which work will begin during 1924, although it may be several years before the capacity indicated will be fully installed. It is impossible to ascertain with accuracy what is projected in each of a thousand localities of this district, or even what is under construction, and no claim is made that the map is complete in this respect, but in the high spots it indicates that the rate of growth is not slackening.

Some parts of the map show bare areas, which might lead one to suppose that these areas are electrical deserts. Such is not in all cases the fact, as there may be many central stations of less than 500 kilowatts, but not connected up in system of greater or less extent, as is shown elsewhere.

Consolidation Produces Great Economics

The great economies possible by consolidating small properties have not been overlooked by capital, and there has long been a scramble for the richer sections of the country, with the outcome that there has resulted a hodgepodge of systems with boundaries more bizarre than those of the various German states. Many local combines are developing and gaining strength and territory, but elsewhere they are being taken over by large holding and operating companies and united into systems. The territory of any one holding company is not contiguous. In fact, all of the holdings are quite spotty, and while there may be some friction around the edges, for the most part these giants are on such neighborly terms with each other that they not only do not fight much, but they interchange power for mutual assistance. At present they are using all the money they can get to acquire and develop neighboring areas and the business within the territories already covered, but I anticipate that the process of consolidation will continue and the present erratic lines will dissolve, forming huge interstate combines capitalized at billions, supplying dependable power in unlimited quantities and at prices that eventually will shock steam locomotives off the rails and will put into the hands of each of our factory operatives ten times the amount of power that his former competitor has.

I have endeavored to give a mere glimpse of the present status of a great business, the magnitude of which few comprehend and whose present rate of growth is such that the business more than doubles every twelve years. The capital necessary annually for this development mounts to fantastic heights, as was said of the German war debt, and yet it is forthcoming as fast as needed. Not as was formerly the case—principally from large capitalists, but from the people—wage earners and others of moderate or small means, and many of whom are customers of the lighting company, in whose future they have confidence and whose interest they jealously guard.

The New Public Ownership of Utilities

The expression, "public ownership of utilities," once to those utilities had a sinister meaning, but they took up the challenge and made the threat come true, although in a way not expected. They changed it from public ownership to ownership by the public, and as such no demagogue dare assail its interest. In Illinois alone probably one hundred thoustand voters are utility stockholders, and all are voting and vocal when their interests are threatened.

No other industry has the rate of growth, no other business has been developed on such strictly scientific lines. Other industries have grown up on intuition and tradition, cut and try seeking in the dark, or rather not seeking but stumbling over facts, some of which are recognized as discoveries; but here is an

industry that was led by scientists from the start, whose every development of abstract theory quickly found a practical application, with a practical reward to the discoverer.

The field is still open with a wider front than ever and the rewards are to the diligent and courageous, be they investigators, executives, constructors or operators; and while not all aspiring young engineers can go to the top at once, they can follow the steep road that leads in that direction or build a new road for themselves.

The foregoing paper, by Mr. Abbott, was presented at the recent annual meeting of the Illinois Society of Engineers.

FEDERAL AND STATE POLICIES IN THE CONSTRUCTION OF THE FEDERAL AID HIGHWAY SYSTEM

By Thomas H. MacDonald, Chief, Bureau of Public Roads, Washington, D. C.

In November, 1921, the Federal Highway Act became a law. In the two-year period since, in addition to administering very large programs of highway construction and maintenance, the State highway departments of the 48 states and the Bureau of Public Roads have selected, correlated, and agreed upon the highway system which is to be first improved under the terms of this Act. This is truly a noteworthy accomplishment. It is at once a promise and an assurance of progress in the development of adequate highways for this nation. There is the appeal of something fine, the challenge of security in our form of government, in the successful planning of this great system of inter-state and inter-county highways through the joint effort of the sovereign States and the Federal Government, each recognizing the aspirations of the other.

Other nations have in times past built great road systems under military dictate, largely for purposes of conquest. The United States plans a system of highways to serve her people in the pursuit of economic freedom and happiness. As now visualized in the first real map of the major system of highways, the conception is truly national, but like all other of our great national institutions, the scheme has been built from the foundation up and not from the top down. We, of the Bureau of Public Roads, are proud of this national plan, yet we most cordially and gladly give the credit for its accomplishment to the State highway departments.

Choosing the Federal Aid System

The choosing of such a system has been a most difficult task. That it has now been brought to a successful conclusion is largely due to the selective processes which the highway departments have been exercising for years. Without this prior classification, which has been the cause of constant and vigorous protests where local and often selfish interests recoiled against the action of the State departments, the welding of a great network of major highways covering the whole nation into a comprehensive plan could not have been possible. The recent task largely narrowed to a process of joining the selected systems of the States, and here again the departments have shown a wonderful spirit of cooperation. Conflicts at State lines have been settled in friendly conference around the table. It is more than evident that the highway departments and the field organizations of the Bureau have carried on the negotiations with sincere good will and mutual respect. The task ahead is defined. It will be completed.

The Present Federal Aid System

The present map includes 168,881 miles in the Federal aid system, about 30,000 miles less than the legal maximum based upon the certified total public road mileage in the United States of 2,886,061 miles. While there remain some details yet to be adjusted, they are in the main relatively unimportant and will not be allowed to cause controversy between the States and the Bureau. Only in one case was it necessary for the secretary to hold a hearing before making his decision, and this was sought by an association having no official status. I am convinced by the experience in this matter that no State highway department should accept financial contributions from any source outside public revenues unless no obligation, actual or implied, is thus incurred. That which may appear to be the proper course to follow today may not be in five years or less. Conditions in the highway field have undergone the most abrupt and unforeseen changes. Each highway department must remain free, morally and legally, to follow the course dictated by the most urgent needs of highway service.

The State and Federal governments are financially able, and the State and Federal highway departments are adminis-

tratively and technically competent to build the roads in the order of greatest importance in the different sections of the country without the assistance of any voluntary organization, if such aid in the end shall become a source of embarrassment.

Progress to Date

As indicative of the task ahead, the combined mileage of State systems as of Jan. 1, 1922, is 220,000 miles. Of these, 80,200 miles are reported surfaced, or 36 per cent. The Federal aid system now approved is about 80 percent of the total State highway mileage, and may be considered to this same extent coincident. Applying the same pro rata of improvement the first of the year 1922, about 30 per cent of the Federal aid system was surfaced, or about 50,000 miles. Of Federal aid highways on July 1, 1923, there had been completed 26,536 miles, and there were under construction 14,771 miles, a total of 41,307 miles of all types. Of these 8,686 miles were graded and drained, and 32,621 miles surfaced. All but a very small percentage of this mileage is on the Federal aid system as now established, and although, admittedly, the above figure of 50,000 miles of surfaced roadways on this system is very rough, still it is apparent that the surfaced improvements added in the four-year period 1920-1923, have been equal to or greater than all the surfacing placed in all the prior years.

The Problem Ahead

A careful study is being made, State by State, of the improvement status of this definite Federal aid system. If these estimates are found to be approximately correct, at the end of 1923 there will be about 60,000 miles of surfaced roadways, and about 8,700 miles graded. This leaves 110,000 miles to be surfaced. To surface this mileage in the ensuing decade, that is, by 1934, there must be an annual program of 11,000 miles of completed new construction. In addition, there must be the "stepping up" of many miles of lower to higher types, the reconstruction of surfaces built before the present traffic, and the widening of roadways to carry the increased traffic. During the ten-year period there will necessarily be added a considerable increment to the present approved mileage.

Incidental Problems

Nor does this yet represent the size of the essential construction program to bring this major system up to a satisfactory operating basis in the next ten years. There are many miles of the system crossing Indian reservations, National Parks and National Forests in our western and southwestern empire. There are many new and important bridges required and a large program of bridge reconstruction, especially in the East and South. Added to all this is the ever-increasing need of safety improvements, such as the elimination of railroad grade crossings.

Financial Problems

These and similar problems are not to be indefinitely deferred. They must be met. From the standpoint of financing new construction, the most acute situations exist in a number of the western States. The new may shows the extensive network covering the eastern and Mississippi Valley States, focusing in a few lines east and west across the Rocky Mountain system, the great central plateau, and the Sierra Nevada system, finally to meet and multiply into the highways of the Pacific Coast States. While limited in number, these in-between connecting links present serious problems—financial and engineering—not through an unbroken length, but at times for long distances, where there is little or no local development, where the physical obstacles to road construction are unusually difficult, or where these necessary links are not so located that they, at the same time, serve the most urgent highway service needs of the communities or the whole State.

The sliding scale of financial cooperation does not meet these conditions. It alleviates, but does not cure. The agricultural depression has hurried the acute status; it is not the cause. The Bureau understands this condition and is in sympathy with its proper solution. This right solution can and must be found. There can be more than one approach. A readjustment of the terms of cooperation to meet specific extraordinary conditions, the general development of more economical design or construction. With the existing status of construction, both as to types and extent, Federal participation in maintenance as a general policy is not the logical solution.

Highway Traffic

The indicated necessary improvement program on the major highway system is large. It must be considered most seriously, but in the light of the amazing growth in highway traffic.

Economic data is becoming available by

which we may measure the need for, and usefulness of, improved highways with certainty, and the conclusion is inevitable that the annual mileage of new roads is lagging behind the expansion of highway traffic. Highway transport is seeking to serve more rapidly than the handicap of inadequate highways is being removed. The State Highway Department of California and the Bureau have made two traffic studies covering the State system, the first in 1920, the second in 1922. At the same 103 counting stations, the two-year numerical increase in daily traffic was 47 per cent, thus closely reflecting the 54 per cent increase in registrations.

The Baltimore milk transportation survery shows 36 per cent of the city's supply now brought in by motor truck. In 1919 only 18 per cent reached the city in this way.

The Connecticut highway transport survey developed beyond question the fact that the direct connections between population centers are the major traffic lines, that the traffic is reasonably proportional to the population concentration in the centers directly connected, and that the heavy traffic, both in weight and number, is restricted to a relatively small percentage of the total mileage of public roads within the State.

The Bureau's predicted total registration for this year is 14,700,000, and for the following year 16,500,000 plus. The extension of freight and passenger lines is bringing rapidly to the individual, highway transport service, whether he is a car owner or not.

The report of Special Committee IV of the United States Chamber of Commerce on the "Relation of Highways and Motor Transport to other Transportation Agencies," states as one of its major conclusions:

"Trunk highways in any area should be able to carry the normal vehicular traffic of that area, and, if the traffic economically justifies the use of especially heavy trucks, highways with stronger sub-bases must be provided. This constitutes a problem requiring particular attention in the design of highway systems and in the regulation of traffic. In other respects present types of highways, present routes connecting principal centers of population and production, and the present trend in size, weight and speed restrictions of vehicles using highways show a rational system of highway development that should be continued."

Highway traffic presents a cross section of the business and social life of the communities. Upon this fact and the definite traffic data now being gathered may be predicated the character, amount and weight of the traffic which the highways should be designed to carry.

The results of the California and Connecticut transport surveys will be available soon. The Bureau is now cooperating with Pennsylvania in similar traffic studies, and desires to work along these lines with othe States as the funds available permit.

Highway Funds

There is a large discussion, much of it critical, of the expenditures for highway purposes. There is particular criticism directed against bonds to pay for the improvements. The tendency on the part of the uninformed and unthinking is to condemn expenditures for such purposes because they are, in and of themselves, large in amount. They forget that no one can pass upon the reasonableness and necessity of a public outlay of money without considering at the same time the utility and value which is brought to the use of the public because of such an expenditure. It is just as logical to judge the soundness of a business concern by looking only at the liability side of its statement without comparing it with the asset side, as it is to criticize expenditures for highway construction without taking into account the value of service which such highways render, i. e. their earning capacity.

We have recognized for years the terrific annual loss due to mud roads and the possible savings, direct and indirect, which accrue to the users of improved roads. A milk truck taking the milk of a certain group of farmers to the Baltimore market had to operate over a five-mile stretch of unimproved road to reach a surfaced road. The regular price of transporting milk is 3c. per gallon. In this case the operator of the truck charges his farmer patrons ½c. per gallon extra for the six-months' period from October to April because of the bad road conditions. These farmers are actually paying $900 annually more than the regular charges, or $180 per mile, or the interest at 5 per cent on $3,600 per mile. This is the actual increased cost for milk alone. Considering the other traffic which exists, it would be economy to spend a considerable amount to improve this road,

even though it should be necessary to borrow the money in order to do it. There is good reason to question the sincerity of these self-constituted "watch dogs" of public funds, who set in motion propaganda against highway expenditures and are silent as to the net savings resulting from them.

In 1921 the Bureau made a thorough survey of all highway expenditures. The results are illuminating. Of the total $1,036,587,772, there was expended by or under the State highway departments $413,241,662, or 40 per cent, while under local authorities there was expended $623,346,110, or 60 per cent. These expenditures were divided as follows:

Expenditures—1921

By or under control of State Highway Departments.

State and State-aid construction	$291,973,813....	70.7%
State and State-aid maintenance	74,526,746....	18 %
Engineering and administration	18,881,855....	4.6%
All other items (a)	27,859,259....	6.7%
Total, States....	$413,241,662....	39.9%

(a) Includes payments of interest and principal of highway bonds, purchase of gravel pits, quarries, etc.

Local Expenditures—1921

Construction, all classes	$334,991,560....	53.7%
Maintenance	174,066,423....	27.9%
Engineering and administration	17,149,498....	2.8%
All other items (a)	97,136,629....	15.6%
Total, local.....	$623,346,110....	60.1%
Grand total expenditures, 1921	$1,036,587,772....	100 %

(a) Includes payments of interest and principal of highway bonds, purchase of gravel pits, quarries, etc.

Remembering that on the basis of a billion-dollar highway program, the division is 40 per cent expended by the State and 60 per cent by the local authorities, note the division of income for all highway purposes.

Total Income for All Rural Highway Purposes—1921

Bonds	$438,109,273....	38.1%
Taxes	415,680,010....	36.2%
Motor Fees	118,942,706....	10.3%
Gas	3,683,460....	.3%
Fed. aid and forest funds	*79,333,226....	6.
Federal aid and forest funds	*79,333,226....	6.9%
All others	93,689,221....	8.2%
Grand Total....	$1,149,437,896....	100. %

*From State reports.

Property taxes contribute direct 36 per cent. As closely as cen be estimated, this is about 10 or 11 per cent of the total annual tax bill, local, State and Federal.

Therefore, if there had been no highway program, State or local, property taxes would only have been reduced by say 11 per cent.

Examine now the division of income for State funds only.

Income to State Highway Funds—1921

State bonds and special assessments	$114,825,637—	28.3%
State taxes, direct.....	46,206,583....	11.4%
State appropriations from general funds..	20,817,354....	5.1%
Funds from Cos., etc...	29,302,653....	7.2%
Motor vehicle fees.....	101,284,479....	25.0%
Gas tax	3,273,988....	.8%
Federal aid and forest funds	79,333,226....	19.6%
Miscellaneous sources	10,494,479....	2.6%
	$405,538,399*	

*There is an apparent discrepancy between State income and expenditure, but it should be remembered that in the conduct of public business, the two are ordinarily not exactly coincident or correlated. The discrepancy here is less than 2 per cent, a most excellent record.

Crediting general property tax with both State taxes and funds from counties, the total is 18.6 per cent. The items of Federal aid, forest funds, motor vehicle and gas tax, total 46 per cent, and State bonds, 28.3, i. e., 73.7 per cent outside direct property taxes. The information is not available to divide the bond retirement and interest between property taxes and motor vehicle and gas taxes.

This is the real truth. The local roads are the cause of property taxes for this purpose being higher. This clamor about taxes is directed at the wrong cause.

These figures are for 1921; the increase in revenues from the motor vehicle and gas taxes are growing rapidly. The total 1921 revenues from this source, including Federal taxes, were more than $350,000,000, equal to 85 per cent of the income to State highways. It exceeds the entire tax bill of the railroads.

The Federal Government has received in taxes on the motor vehicle and repair parts more than double its entire expenditure for Federal aid.

The greatest danger we face in completing the Federal aid system or the State systems, are the drives against these funds for local roads, and even for purposes having not the most remote relation to highway improvement. The very life of the highway departments and major highway program depend upon these revenues.

This is the stern fight ahead. Property taxes can and should pay for the local program until the major one is complete, and if property taxes are too high the local program of new construction can be smaller for the time.

From this general discussion of the

present situation, and from the experience in each State, the conclusion is certain that the improvement of the Federal aid highway system is the most important big task ahead, not because it is the Federal aid system, but because it comprises the most important inter-state and inter-county highways of the nation, the very framework of the whole structure, and that with its improvement heavy traffic will more and more concentrate on it, thus relieving other roads. But that no matter how important this may be, there will be determined efforts to divert the necessary funds to roads of lesser traffic importance, but totaling a much larger aggregate mileage. Even though well begun, the big work of the State highway departments and the Bureau has only just begun. There must be established closer and more sympathetic understanding, and in this the Bureau desires to meet the States more than half way. The public is impatient. It is demanding increased highway service, and this service can only be rendered by better maintenance, by as large an annual program of construction of roads suited to the needs as the funds will permit, by better construction, and by reducing costs. These objectives can only be accomplished by more efficient administration and engineering, now made possible by the great advance in the science of highway engineering. Each State has its particular problems. If some States have larger available revenues, they, too, have the heaviest traffic problems. There are plenty of thorns with the roses in all the States.

Maintenance

Sometimes questions that come to me indicate a feeling that the Bureau is inclined to deal narrowly in approving Federal aid projects, but such is not the case. The Bureau desires to meet the States on the broad basis of faith that the expenditure of Federal appropriations for road purposes is an investment which will return many fold in measurable benefits. Objections are raised if the proposed construction appears unsuited for the traffic service demanded or that the maintenance will be difficult or impossible, and the costs will be unnecessarily high.

Under the law the Bureau cannot participate in the expense of maintenance. This expense ought to be met from the revenues from the motor vehicle license fees and the gas taxes imposed now by 36 States, i. e., it should be paid by the road user. Proper original construction will do more to decrease maintenance costs than any other factor, and the Bureau will meet the States to the fullest extent compatible with the law to secure such construction.

There are supplementary practices which we consider desirable, for example, the seeding of embankments and side slopes of grades, and other work calculated to protect and thus decrease maintenance costs.

It is our judgment that the limitation now imposed on the allowable participation per mile should be removed to enable participation on paved roadways on heavy traffic roads not less than 20 ft. wide. While 18 ft. is regarded as sufficient for two-way traffic, the 20-ft. widths are already indicating a lessened maintenance cost and a more usable width.

Stage Construction

The proper balance between maintenance and construction costs is one which each State may not always determine on its merits. Many States have been forced to build roads of lower types because of lack of funds and a demand for a larger mileage than is justifiable from the maintenance standpoint but necessary from the standpoint of traffic service to the public.

The stage construction policies of the Bureau seem not to be understood in some States. The Bureau is willing to approve stage construction and the most economical types or processes that it is possible to devise, whether these are regarded as standard or not. The stage construction policy is sound and practically all of the road work in the United States may be regarded on this basis now, since it has been definitely proven possible, assuming the original alignment and grades are adequate to build up existing types to meet increased traffic. We need to extend this policy and to develop new designs. Processes ought to be simplified, and we are ready to meet economies of this character even to the extent of extending project agreements to cover more than one construction season.

For example, there are many roads which for lack of funds have been only graded and drained which would be greatly improved by the addition of sand where the traffic is not too heavy and where the soil is of the clay and gumbo types. There are many miles of such roads in the great agricultural States of the Mississippi Valley. This material

could be applied in thin layers through say two construction seasons until a maintainable surface is built. The same policy could be followed in building gravel roads where the material is of the fine type and where water and rolling add undue expense. The stage construction policy must be carried out in good faith. The Bureau regards as real contracts the grading projects approved for later surfacing. There is a real danger in extending grading and draining too far ahead of the final construction, and already this situation exists to a limited extent. Lack of funds to build as original construction a suitable type for the traffic is the only possible reason for the use of the stage construction where the improvement does not extend beyond grading and draining unless there is difficult clearing or time is needed to allow the settlement of high fills. The greatest danger in stage construction lies in the possibility of not being able to secure funds for higher type surfacings where actually needed.

Subgrades

The character of the subgrade has a very large effect upon the stability of the road surface. The difference between good and poor subgrade materials has long been recognized. It is a more difficult matter to decide where the boundary line exists between a bad soil and one that will provide adequate supporting power under any moisture condition. Recently the Bureau has placed a memorandum before the district engineers calling for subgrade treatments of plastic soils, such as the clays and gumbos, before placing high type surfaces. The practice already exists in some States of stabilizing the subgrades where bad soils are encountered before building the surface, and this practice should be adopted generally.

There is need for cooperation between the Bureau and the States in establishing the relation between field behavior and laboratory analysis. It is believed that very simple tests will determine the soils which should be modified before surfaces are placed and that the treatment itself can be of a simple, economical type. Silt and sand are both effective. Recently the Bureau tested the effect of the addition of Portland cement to a clay subgrade with marked results. One part of cement was mixed with 28 parts of soil to a depth of one foot. Concrete slabs 6 inches in thickness were laid on this subgrade, and corresponding concrete slabs were laid on an untreated subgrade. The slabs were then tested under impact simulating truck action. The slabs on the cement-treated subgrade broke under loads which created a pressure under the wheel of 18,000 lbs., while the slabs on the untreated subgrade broke under a pressure of about 12,000 lbs. The bearing values of the treated soil showed great improvement, and when mixed with water had apparently lost its plasticity, while the untreated soil was plastic. Similar results can be obtained with the use of other materials.

It appears that with very simple but intelligent methods, the stability of bad soils may be materially increased at an expenditure very small relative to the results that may be secured in the addition to service life of the completed roadway.

Railroad Crossings

Generally speaking, the States are fully cooperating in the elimination of grade crossings on new construction. From the records of the Bureau, out of a total of 753 crossings which have been eliminated, 467, or 62 per cent, have eben eliminated by relocation, 286, or 38 per cent, by grade separation. In spite of the progress along this line in the work that has already been done to bring about a separation of grades, there still exist many grade crossings on important traffic routes. It appears reasonable and advisable that each State should adopt definite policies fixing an annual program of crossing elimination or of improvement providing for more adequate protection and safeguarding of the public.

In dealing with a problem of this kind it is always better to secure adequate data for each crossing. The Bureau will very gladly cooperate with each State in the examination of the crossings now existing on the Federal highway system to the end that a proper classification of these crossings might be made and a program of improvement or elimination set up. The railroads constitute a third party which should be taken into consultation since they must participate in such a program. It is difficult to fix upon an annual program which would, within a reasonable length of time, eliminate this source of danger from our principal highways without definite information as to its full extent. There is no reason why such a determination might not be made independently of the progress of

the construction program, as there is no reason why the improvement of such crossings should not be taken up as single projects without waiting for the construction of the roads on which they occur. Unless a policy of this character is established it is more than likely that the most dangerous crossings will not receive prior attention.

Safety and Accidents

While the grade crossing problem is one of the most serious, there are many accidents occurring which are not a product of this cause. Upon inquiry, the Bureau finds that only eight States attempt to keep a complete record of accidents occurring on the highways. These States are:

Connecticut,
Indiana,
Maryland,
Massachusetts,
Rhode Island,
Vermont,
Virginia, and
Wisconsin.

In these States the automobilist is required by law, in case of an accident, to make a complete report to either the Commissioner of Motor Vehicles, the Commissioner of Highways, the Secretary of State, or to the nearest judicial official. In general, the laws also provide a penalty for failure to make such a report. In some of these States the report forms include typical sketches of the location where the accident occurred, and information as to its occurrence on a curve, reverse curve, tangent, road intersection, etc. In certain States additional information is obtained from highway patrolmen and from maintenance men, and from other local highway employes.

It appears to be very important for the States to have complete data covering this matter of accidents so that it will be possible for those in authority to take the proper steps to eliminate causes which are directly attributable to the physical condition of the highways. In the main, accidents should be classified as to their results (number dead, number injured)—time (daylight, darkness)—location (railroad grade crossing, intersecting highways, tangents, curves, grades, detours) and cause (faulty operation, faulty equipment, weather condition, highway condition). These elements of the cause of accidents can be split up into greater details. For instance, under the heading of highway conditions, there should be a notation of lack of sight distance (forward or horiontal), a narrow highway, a narrow bridge or culvert, inadequate, irregular or improper wording or spacing of signs, lack of guard rail to outline roadway and warn motorists, unnecessary obstacles to view, failure to make prompt repair to holes or depressions in the pavements, excessive crown. There may be other elements of the physical condition of roads which should be inquired into in case of highway accidents.

Field Inspection

It appears that preliminary engineering and designing have moved far ahead of the field control of actual construction operation. The importance of adequate and competent field inspection cannot be over-stressed. This should extend to field tests of material which can be checked by the headquarters laboratory. There has been a great improvement during the past three years, and most of the States recognize the importance of competent field inspection, but there is still a tendency to economize on personnel to such an extent that adequate engineering inspection is not always given.

This inadequate inspection extends to bridge construction. Both the Bureau and the States should strengthen their work in this regard, and should resort to new methods of inspection that will more adequately secure a compliance with the plans, specifications and contracts. The use of a light-sounding hammer for testing reinforced concrete bridge construction has proven the presence of poor concrete where surface indications were reasonably good. The profilometer developed by the Illinois Highway Department provides a possible means for testing the surface secured in pavement construction and its proper use will result in higher standards of workmanship. The use of coring machines should be greatly extended. The general use of this machine to check the compliance with contracts in North Carolina is highly commended, and the results secured should lead to the universal adoption of this plan of determining not only the adequacy of the engineering control in the field, but of providing a method for settling with contractors on the basis of actual work done. The Bureau will cooperate with the States in helping to operate this equipment to any extent desired.

Laboratory Control of Materials

Undoubtedly each State should establish its own testing laboratory. There has been such a demand upon material sources that too often the laboratory examination of materials has been only a paper compliance. That is, the information secured has had too little effect upon the materials actually going into the construction. The responsibility for the use of proper materials extends beyond the program under State control. Local authorities would be assisted if the results of tests were made known. For example, on one Federal aid job, a sand was rejected which had already been used on over 300 miles of county roads. The plan of having the testing done at university laboratories cannot be relied upon for any considerable paving program, nor can a commercial laboratory compete with the service rendered by a properly equipped testing division. Just half of the States are now operating State laboratories, the others being dependent upon the commercial or university laboratories. The inspection of materials at their source is highly desirable, and this plan is used by some States. There is no reason why cement, for example, should not be tested at the manufacturing plant, and cooperation between adjoining States purchasing from the same mills might well be established with resulting economy. Material surveys would develop new sources of materials, and if these surveys are followed by testing of the materials, the State has at hand the information on which to base its construction program. The Bureau has established in each district a material engineer, and we hope to develop a helpful service to the States in this manner.

Detours

Traffic service must be maintained during construction. It must be given greater attention. The policy of maintaining parallel routes by the State, depending on the contractor to maintain driveways only when on the right-of-way under construction, as used in North Carolina and other States, is probably the most satisfactory practice. The maintaining of detours is a proper expenditure from Federal aid funds. This Association should undertake at once leadership in developing uniform traffic regulations.

Developing the Organization

One word, in closing, about personnel training. Fundamentally, the highway problem remains one of education. The men who come after us must be better trained. The organizations must be fed from the bottom with keen, intelligent young men. They must have a chance at broad development in the various branches of the work. They must at the same time get their minds in tune with the spirit of public service.

The foregoing paper, by Mr. MacDonald, was presented at the 1923 meeting of the American Association of State Highway officials.

RELATION OF LOW-PRESSURE HEATING BOILERS TO MUNICIPAL SMOKE PROBLEM

Director E. R. Weidlein of Mellon Institute of Industrial Research of the University of Pittsburgh has announced an investigation of public interest because of the fact that it will involve a scientific study of the relation of low-pressure heating boilers, of the type in general use in all residences, apartment houses, and office buildings, to the city smoke problem. It is expected that this research, which has been begun as a part of the Institute's Industrial Fellowship on air pollution and its abatement, will aid materially in solving the problem of boiler requirements for specific purposes, with due consideration to fuel economy and smokeless operation. The result will be an enormous saving in coal used in American cities and minimization of an important contributing factor to the municipal smoke problem. It will be a valuable contribution to public health.

Due to the waning supply of natural gas in the Pittsburgh district, the use of coal as a domestic fuel is increasing enormously. A constantly growing number of the 100,000 private dwellings in the city of Pittsburgh, not to mention hotels, apartment and office buildings, stores, etc., are turning to coal and coal-fired boilers.

Smoke abatement has been an important problem in American municipalities for years and in many urban communities ordinances have been passed prohibiting the emission of unreasonable volumes of dense smoke. One of the sources—in many localities the principal source—of smoke is the heating boiler. Manufacturers have designed "smokeless" boilers intended to operate within the limits set by anti-smoke ordinances and great advances along this line have been made

within the last few years. In rating the capacities of these boilers, however, manufacturers have not used uniform methods, nor has the information furnished been such that the prospective purchaser can interpret it in terms with which he is familiar, so that he may determine that he is getting what he needs—not less and not more beyond a reasonable factor of safety.

Boilers have been rated on "square feet of radiation" and it has been the practice for engineers and contractors to calculate the necessary amount of radiation, then to double this quantity to allow for losses in the line and for a factor of safety. This rule-of-thumb method results, in a large percentage of cases, in providing more boiler capacity than is necessary. And, of course, chimneys are required according to the rating of the boiler. Where several boilers have the same rating but perform differently, they will, under the present custom, require the same size stack. This requirement may in one case be entirely satisfactory; in another, it may be insufficient, necessitating the expenditure of additional money on the part of the owner to increase the height; and in a third case it may be more than adequate. As a matter of fact, all boilers evaporating the same quantities of water do not require exactly the same amount of coal nor always the same draft.

Believing that the prospective purchaser is entitled to certain fundamental information, which will enable him to know what he may reasonably expect in the matter of performance from a particular boiler, and also to enable him to know, within reasonable limits, what size boiler shall satisfy his needs, H. B. Meller, of Mellon Institute of Industrial Research, and Chief of the Bureau of Smoke Regulation, Department of Public Health, of the City of Pittsburgh, after a number of conferences with manufacturers of low-pressure heating boilers, is asking each one to furnish the following information for each type and size of boiler:

(a). Total equivalent evaporation per hour in pounds of clean water, from and at 212 deg. F., at the nozzle, 97 percent dry.

(b). Grate area in square feet used to obtain this evaporation. If upper and lower grates are used, each is to be stated separately.

(c). Total coal required, in pounds per hour, to obtain evaporation in (a), with grates (b), with such attention to boiler and fire as may be necessary.

(d). Draft, in inches of water at the outer edge of the smoke collar, necessary to obtain evaporation in (a), with grates (b), with coal consumption (c). The effective area of smoke pipe and chimney to be at least equal to the area of the smoke collar on the boiler.

Tests are to be made in accordance with the code for testing boilers as issued by the American Society of Heating and Ventilating Engineers, except that all data are to be furnished for bituminous coal of 13,000 B. t. u. value, with volatile content between 30 percent and 40 percent for bituminous coal-burning boilers, offered for use under the provisions of the Pittsburgh anti-smoke ordinance.

When this information is received, it will be tabulated and published by Mellon Institute of Industrial Research, for information of architects, engineers, contractors and prospective users of heating boilers. Proper factors will be included for extreme weather and other varying conditions. It is expected, also, to include simple formulas for the determination of the amount of heat required for a building under stated conditions, or the amount of direct radiation which can be figured in terms of the boiler capacity required and the size of the chimney necessary. Tests probably will be made with other types of coal and proper conversion tables prepared, so that the standard may be adopted for any section of the country.

It is anticipated that this work will result in standardization of information of value to the public and will state the requirements in terms which the layman can understand.

All the manufacturers with whom Mr. Meller has conferred, have expressed themselves as heartily in favor of this method of standardization, even though it will be necessary for them to spend considerable time and money to secure the specific data required. It will benefit the manufacturer because he will know that other manufacturers are stating their information in the same terms obtained in the same way, and he can specify more closely the conditions necessary for the proper performance of his boiler. It will benefit the purchaser as he will know that he is getting what he needs. And it will benefit the community as it will be possible to determine, with much greater degree of certainty, what boiler capacity and stack are necessary in a given case,

and thus secure better smoke conditions.

There will be no attempt to control design in any way; merely to learn and to tabulate the capacities of "smokeless" boilers together with the conditions under which these capacities may be reached, with the idea of having an installation that is proportioned properly throughout.

Any good method of standardization results in more economic operation. The total consumption of coal for all types of boilers and furnaces in the city of Pittsburgh for the year 1923 was approximately 7,000,000 tons. A 1 percent saving would be equivalent to 70,000 tons.

This work at Mellon Institute of Industrial Research in cooperation with the Bureau of Smoke Regulation of the City, is a part of the Institute's broad study of the general problem of air pollution. The industrial aspects of the subject will receive simultaneous attention, thus continuing another investigation already begun under the supervision of Mr. Meller.

VALUABLE TRADE LITERATURE

Street Lighting—The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has issued two supplements to its 1923-24 catalog of electrical supplies. The first, Supplement 1 to Section 8-A of the catalog, covers the description and applications of the Westinghouse Bi-Lux Refractor and the Holophane Two-Way and Four-Way Refractors for overhead street lighting. The second, Supplement 3 to Section 8-B, includes a description and applications of the Bi-Lux Refractor for ornamental street lighting. Both of these supplements show candle power distribution charts for each of the refractors described.

Construction of Vitrified Brick Pavements—A 92 page booklet, size 6x9 ins., profusely illustrated. Compiled and issued by the National Paving Brick Manufacturers' Association, Cleveland, Ohio. Describes the construction of vitrified brick pavements. Is up to date on every detail of sound practice. Contains recommended specifications for drainage, grading, bases, bedding, laying brick and filler. Also gives miscellaneous uses of vitrified brick with specifications for private drives and walks, heavy duty floors and walls, sewers, bridges and railroad and architectural uses.

City Pumping Equipment—The water works pumping station of the City of Allentown, Pa., is described in an illustrated leaflet issued by the De Laval Steam Turbine Co., of Trenton, N. J. The station as a whole may be considered as a good example of a reliable and economical plant for a small city. The water supply for the 85,000 inhabitants is taken from two springs, one located near the pumping station and the other at a distance of five miles, and cool, clear and pure water is supplied to 19,000 connections at a single family rate of only $3.75 net per year. The pressure varies from 40 to 100 lbs., which is sufficient for fire purposes. The principal pumping equipment consists of two centrifugal pumps designed to be driven either by steam turbine or by an electric motor using purchased electric power, the units being mounted upon an elevated platform above flood level, so that the pumps can continue to operate in case the steam supply fails due to flooding of the pumping station.

Highway Lighting—The problem of lighting the public highways, one of the most recent developments in the field of illumination, is discussed in attractive 4 page, 2 color folder, "Light On the Highway" published by the Westinghouse Electric and Manufacturing Company. This folder, known as D.M.F. 4809, sets forth fully and concisely the various aspects of the question of properly illuminating the highway. A few well chosen photographs and drawings complete the information contained. The leaflet shows, first, the actual need for adequate lighting of the highway as indicated by the number of accidents due to the use of glaring automobile headlights. The two essential conditions for proper road lighting are the provision of a clear view of the whole roadway for a considerable distance ahead of the car and the elimination of glare within the range of vision of the driver. The headlights in common use on automobiles fulfill the first condition, but as yet, no suitable headlight device has been developed for the second. A description of the construction and operation of the new Westinghouse highway lighting unit shows how it meets both of these necessary conditions. The meaning of highway lighting and how it differs from street lighting is next set forth. The varied and desirable results of such an installation in preventing accidents, increasing property values, attracting desirable traffic and relieving the daytime congestion are brought out. A brief summary of the advantages of the Westinghouse unit concludes the folder.

EDITORIALS

IMMIGRATION AND THE CONSTRUCTION INDUSTRY

Congress seems determined to hold down the influx of foreigners until the United States again becomes a nation in fact, as well as in name, and we think Congress is right. It is a serious question whether or not the United States was a nation at the outbreak of the world war. The great heart of the country was sound, the rural districts and the small secondary cities, but some of the great cities were not. They were merely "polyglot boarding houses," as Roosevelt so aptly termed them. Large sections of these great cities were foreign in every sense except that of location. They were among us but not of us. These people worked here but lived apart, hoarded their money and sent it "home," and recognized no allegiance except to their several homelands. They could not speak our language and made no great effort to learn it. They built up great European colonies in our midst and despised every thing American except the American dollar.

Many persons realized at the time that had we entered the world war much sooner than we did we should have had something more serious than draft riots to deal with. The national election of 1920, advertised as "a great and solemn referendum," degenerated into a race riot and millions went to the poles to vote their racial animosities. The fact that the situation had become bad enough to arouse even Congress shows how bad it really was.

In recent years most of the opposition to a rigid restriction of immigration has come from the great manufacturing and construction interests. This is easily understandable because of our desire for cheap labor. That this sort of labor has done much to build up the country in a physical sense no one will deny. But since it promises to destroy, or seriously impair, our national unity other considerations become more important than that of cheap labor. We hope the construction industry will withdraw its opposition to the virtual exclusion of "men of the meaner sort" until we have made Americans out of those of this type already here. This is an end worthy of any sacrifice.

THE YOUNG ENGINEER'S FIRST JOB

The 1924 graduates from engineering colleges will soon be seeking positions; in fact, even now these young men are doing what they can to place themselves to advantage as soon as they graduate. We hope experienced engineers will take time to advise with these boys whenever opportunity offers. Few things give more satisfaction than helping a young engineer get a start in the profession.

Few graduates have a decided preference for a particular line of work. This is natural as only experience can teach a man what he likes and what he dislikes. The important thing is to make a start. Many say it is of no importance where or how the young engineer starts but this is not true. The first position should be chosen, if possible, to fix in the young man's mind the theory he has learned and still retains. For this purpose an office job is better than a field job. An office job, involving more or less of engineering design, will give him prompt application of academic theory and will so fix it in his mind that he will long remember it, even after serving a later apprenticeship in the field. On the contrary, if he takes a field job first he will forget most of the theory he learned in college before he has a chance to apply it. We, believe, therefore, that it is wise to advise the young graduate to take up office work first.

Work in a small office is likely to give broader experience than work in a large

office. Generally speaking, the best job the beginner can have is in a comparatively small office handling a variety of work. This not only gives him experience quickly but enables him to discover his professional likes and dislikes with a minimum loss of time.

BASING TRUCK PENALTIES ON MISINFORMATION

Something approximating the proportions of a tidal wave of hostility to the motor truck passed over this country in 1922. The legislature of nearly all states convened in 1923 and every one of these legislatures was fully determined to "soak the motor truck." Much of this hostility was based on misinformation and on no information at all. It was based on assertions which were at variance with the facts. Now the flood waters of truck opposition have receded somewhat and a few fundamental truths are beginning to show up like peaks through the clouds. Information is being substituted for misinformation and when the legislators meet again in 1925 they will know what they are talking about, which was not the case with respect to motor trucks in 1923.

The first great error about trucks is that most of them are of enormous size. Mention a truck to the average legislator and he thinks of the biggest truck he ever saw. His tendency is to legislate against trucks as if they were all of the heavy duty variety. Now the fact is that between 80 and 90 per cent of all trucks are of 1-ton capacity or less.

Another fundamental mistake was in assuming that all trucks are destroyers of rural highways. As a matter of fact the majority of trucks, especially the heavy ones, never leave city pavements from one year's end to another.

Again, the legislator of 1923 considered all trucks as vehicles for hire. Only a very small percentage of trucks are operated for hire and practically all these are in city cartage and transfer service. While intercity trucking is promising it is very much in its infancy. Of the trucks for hire a very small percentage ever use rural highways.

Another mistake made was in assuming that mere size in trucks is ruinous to roads. Overloading rather than size is the thing to discourage. An overloaded light truck will do more damage to a road than a properly loaded heavy truck. The light truck is not tired and sprung for a heavy load and when heavily loaded does do damage. Overloading, then, and not mere size is the thing to penalize.

But the misinformation of 1923 was too extensive for review at this time. Happily much of it has been dispelled. It is hoped that our lawmakers will be given facts to work with in future. If they have the facts they will legislate wisely and well.

PORTABLE PUMPERS VS. BOOSTER PUMPS

Water works operators are becoming increasingly critical of booster pumps to increase the pressure in the water distribution system to yield fire streams during fires. They much prefer portable pumpers in the interest of safety.

Our water distribution systems are growing old and show the infirmities of age. They can handle ordinary demands satisfactorily, in most cases, but are likely to fail under extraordinary demands at the very time, of course, when failure is most disastrous. A distribution system that is plenty good enough to carry water at low pressure to portable pumpers for fire protection purposes may break down under the high pressures required where the fire streams are taken off direct from fire hydrants. Even if broken mains and interrupted service do not result from suddenly applying high pressure, numerous small leaks are almost sure to be opened up and this leakage, in diminished amount, will continue after normal pressure is restored, thereby adding enormously to water waste.

Water works men are conservative by nature and not given to the making of strong assertions on any subject without just cause. Their condemnation, therefore, of the practice of furnishing fire streams direct merits great respect. These men realize that in almost any city where this obsolescent method is still in vogue a great disaster is likely to occur any time a fire starts. Broken water mains render the best fire fighters almost helpless and it is against this contingency that the water works men warn us. Undoubtedly they almost unanimously counsel the use of portable pumpers.

WATER WORKS AND THE FIRE PROTECTION OF SMALL MUNICIPALITIES

By Charles W. Parsons, Engineer, Illinois Inspection Bureau, 37 S. Wabash Ave.,... Chicago, Ill.

Engineers in designing new water supply systems, and in laying out improvements and extensions for existing systems, and superintendents in planning and supervising improvements in their own water works are confronted with many problems. The fundamental problem is to furnish the best possible service for the least possible cost. This service should meet the requirements of both the domestic consumption and adequate fire protection.

Small Town Fire Requirements

In the smaller municipalities the requirements for fire protection very often are not appreciated and consequently are greatly under estimated or sometimes almost entirely ignored. The average small city fortunately has comparatively few fires per year and the aggregate of high values in the mercantile district is proportionately less than in the larger business centers. These two features tend to give the citizens a false sense of security and often of indifference to the need of reliable fire protection.

Domestic Use

The domestic use of water is an almost involuntary part of the every day program in the home and place of business and any slight irregularity or very brief interruption of the usual pressure or quantity is given immediate attention and proper steps are taken to prevent a reoccurence. The principal function of the water system as casually defined by the ordinary citizen would then seem to be the supplying of pure water in quantities sufficient for the domestic consumption. The question of providing fire protection would consequently appear to be an important although secondary consideration. It would naturally follow that the design and enlargement of water works should be made in such a way as most economically and satisfactorily to fulfill the requirements of this purpose for which it is apparently maintained. Engineers and superintendents, of course, comply with the wishes of the citizens and make the necessary provisions and extensions for maintaining the best possible service to the consumers with the funds available. Whatever surplus money and equipment can be obtained is put to its best use for improving the ability of the water works for furnishing fire protection to the community.

In spite of this popular conception of the relative importance of the dual functions of a water system, the fire flow necessary properly to control larger fires in mercantile districts is from 5 to 25 times the domestic consumption in the same city. This ratio of required fire flow to domestic consumption is greater for the smaller cities and presents a difficult problem to the municipality which desires to provide a reasonable amount of protection for the safety of life and property from fire.

Strengthening Water System at Small Cost

It is the aim of this paper very briefly to point out a few ways in which a water supply system can be materially strengthened, at a minimum cost, to furnish more adequate and reliable fire protection.

The cities in Illinois, as well as those in many other states, are classified according to the value of their fire protection, as measured by the requirements of an engineering grading schedule which was prepared by the National Board of Fire Underwriters, from the practical experiences of fire protection engineers, water superintendents and fire chiefs. Under the provisions of this schedule definite quantities of water are prescribed for the adequate protection of cities of different sizes and corresponding standards set for each part of the water works through which these quantities must be passed to reach the fire. The proportion in which these requirements are met is the measure of the quality of the protection afforded by these facilities, and is the means of arriving at the insurance classification of the city.

Grading Parts of a Water System

Each of the several component parts of a water supply system is measured with respect to its adequacy or normal capacity to furnish the domestic consumption, plus the required fire flow. These are compared to determine which is the weakest part, or the limiting feature, of the entire system and the one which should first be improved. A similar analysis is made of the reliability of each part of the system or the capacity remaining after a break has occurred at the most critical location.

The distribution system is carefully studied and actual tests made to ascertain if the size of the main arteries, the sec-

ondary feeders and the pipe in the grid-iron is sufficient to provide the necessary amount of water to each section of the city. The location, size and condition of hydrants is investigated to determine the ease with which the necessary quantities of water can be thrown on a fire in any building. Many other parts of the water supply system are thoroughly studied and graded with respect to their ability properly to fulfill their particular function as a fire fighting facility.

In the continual application of this grading schedule to various types of water works it is surprising to note the very frequent re-occurence of the same points of weakness. Four suggestions will be briefly outlined for strengthening those points which are of the greatest relative importance. Such improvements will materially increase the adequacy and reliability of the fire protection which can be furnished by a water works to a small municipality.

Increasing Suction Storage Capacity

Greater suction storage capacity is probably the most important of these four considerations. Storage lessens the requirements of those parts of the system through which its supply has already passed. Thus greater suction storage for the high lift pumps reduces the necessary well yield, filter capacity and low lift pumping capacity, for maintaining the full required fire flow. The source of supply should be developed to such an extent that the well yield or the minimum stream flow, the low lift pumping capacity and the filter capacity should be as great as economically possible, and at least several times the maximum domestic consumption. Only such quantities as are in excess of the maximum rate of domestic consumption would be available at the hydrant for fire fighting. Since the required flow is from 5 to 25 times this domestic rate it is often prohibitive to provide additional wells or corresponding sources of supply to furnish all of this additional quantity. The grading schedule prescribes that the required fire flow shall be available throughout a 10-hour period, or in very small cities a 5-hour period. These requirements would therefore be fulfilled, for all portions of the supply works up to the high lift pumps, by a suction storage reservoir which together with the source of supply would generally be much less expensive than providing deep well pumps and filters of sufficient capacity to carry the greatly increased load necessary properly to control large fires. The investment in the construction of a covered surface reservoir of sufficient capacity for this purpose would enable a great many of the small cities to obtain much more adequate and reliable fire protection.

Capacity of High Lift Pumps

High lift pumps should have a total capacity in excess of the sum of the domestic consumption and fire flow and should be properly arranged to pump from the storage reservoir as well as from the normal source of supply. This high lift capacity may likewise be reduced in proportion to the quantity which has passed these pumps and is available from elevated storage at the required fire pressure. Credit can be given for this elevated storage only at the rate at which it can be uniformly depleted over a 10-hour period. Unless the topography of the city makes elevated reservoirs possible, the cost of standpipes and elevated tanks greatly restricts their size so that beyond certain limits additional pumping capacity is cheaper than larger tanks. The capacity of the supply mains must likewise be equal to the requirements, to assure the adequacy of all portions of the water supply system.

Reliability or Duplication

Reliability or duplication is the second point for consideration. Pumps and all piping and supply mains should be so duplicated thta no single break could cut off the supply to the built up portions of the city. All pumping stations, regardless of the size of the city, should have at least two high-lift pumps so that a substantial supply can be furnished while either pump is undergoing necessary repairs. Each pump should have an individual suction from the storage reservoir with connection to the normal source of supply. The discharge header should be so arranged and gated that no single break or repair of a valve would place more than one pump out of service. This would require two gates in the header between each pump. Two supply mains of adequate size should extend into the distribution system and should preferably enter the mercantile district from opposite sides. The pumping station should be entirely of fire resistive construction and all internal hazards properly safeguarded in order to minimize the liability of an interruption of service by fire.

Many water works have been found which have two or more pumps and more

than one supply main to the distribution system, and yet have a common discharge header, the repair of which would cause a shut down of the entire pumping station and the total interruption of the supply to the city. This is a very important consideration in the design of new plants and often a very easy means of materially increasing the reliability of existing supply works.

In the majority of the smaller cities of Illinois, for example, the pumping station is located within a reasonable distance of the closely built portion of the city and in many instances is within a few blocks of the mercantile district. In most of these cities the cost of a second supply main of adequate size would be more than offset by the substantially increased capacity of these mains under normal conditions and by avoiding a total interruption of the supply in case of a single break in either line.

Where the duplication of the single supply main is not economically feasible, it is often very inexpensive to extend a moderate sized feeder from the pumping station to the nearest point of the distribution system. Such a connection will enable a limited quantity to be supplied to all portions of the city while repairs are being made on the principal supply line. These provisions for duplicating each part of the water supply system, and for the installation of sufficient valves to prevent any single break from resulting in an interruption of the supply, are most important to the health and convenience of the citizens and are even more essential to the safeguarding of life and property against fire.

Undersize Mains

Our third consideration will be 4-in. mains. It might seem rather unnecessary to dwell upon this familiar subject again, when so much has been said against the installation of this small pipe in fire protection systems. In spite of the acknowledged fact that 4-in. mains are entirely too small for this service, a surprisingly large amount is being installed every year and especially in cities of the size that we are discussing. The most common excuse is the apparent lower cost. A second argument is that portions of the city supplied through this under-sized pipe will probably not grow to require quantities in excess of its capacity.

Ample theoretical data and results of innumerable tests are readily available and no attempt will be made here to point out the degree to which the capacity of a fire protection system is limited by the excessive friction loss in 4-in. mains. While the cost of 6-in. pipe is somewhat greater than 4-in., the cost of laying is nearly the same and the capacity is nearly three times that of 4-in. When original installations are entirely of 6-in. mains with 8-in. feeders at frequent intervals, a material growth of that portion of the city may occur before it will be necessary to provide larger arteries. On the other hand when 4-in. mains are laid because of the existing low consumption in newer districts, it will be necessary to replace a considerable amount with 8-in. or larger pipe as soon as the city has been built up and the increased domestic consumption and fire flow require a materially stronger arterial system. The best engineering and economic solution of that problem is to follow the practice of many progressive cities and use nothing smaller than 6-in. pipe.

Fire Hydrants

Our fourth and last consideration is the location, size and condition of hydrants. The proper spacing of hydrants is determined by the fire flow required for the district being protected. Sufficient hydrants should be located within such a distance of any group of buildings that this required fire flow may be thrown on the fire with the necessary nozzle pressure. The high friction loss in fire hose limits the efficient length of such lines to two or three hundred feet, at the pressures usually available at the hydrant. The small mains often found in smaller cities usually make it impossible to obtain more than two standard hose streams from a single hydrant. Where the fire department is equipped with automobile pumpers, quantities up to the capacity of such pumpers, if available at the hydrant, may be forced through longer lines and be thrown on the fire at a higher nozzle pressure. Under such conditions satisfactory streams will be available within a greater radius of each hydrant. The spacing of hydrants is commonly referred to in terms of the average area served per hydrant. The allowable area served per hydrant varies from 40,000 to 100,000 sq. ft., depending upon the protection required, and usually proportionally with the decreasing size of the city. This area is greater in cities provided with automobile pumpers.

Hydrants should have at least one 4½-in. outlet, two 2½-in outlets, a 6-in.

barrel, 5-in. valve and a 6-in. gated connection to the street main. Hydrants in many of the smaller cities unfortunately fall short of this standard in several respects and materially decreases the adequacy of the water supply system. The installation of hydrants with an undersized barrel and foot valve is gradually being discontinued but the use of a 4-in. connection to the street main and the omission of valves in this connection is still being followed in numerous small cities. The friction losses in the undersized branch and barrel under a heavy fire flow are excessive, and are an unnecessary burden on the other parts of the water works. The cost of individual valves for hydrant branches is more than offset by the ability to repair or replace a hydrant without the necessity of shutting off the supply from several blocks, or where the valve spacing is poor, from a considerable portion of the city. The popularity of the automobile pumper, even in the small cities, makes it good practice to install hydrants having a 4½-in. outlet even where such a pumper is not actually in service. Where it is not feasible entirely to replace the existing small hydrants, those near the mercantile and other high value districts should be replaced, or at least removed to outlying sections, and proper sized hydrants with the 4½-in. outlet installed, so that the required large quantities will be available for the control of serious fires.

Hydrants need a fair amount of attention. They should be inspected in the spring and fall of each year, after being used at fires and daily in closely built districts during freezing weather. A large investment in equipment and efficient operation of all other parts of a water works may have been largely in vain if a hydrant has been neglected and fails to perform its function at the critical moment.

Summary

In conclusion, we will name again the four suggestions which have been outlined for strengthening those parts of a water works that have such an important part in providing adequate and reliable fire protection for the small municipality.

1. Substantial suction storage for the high lift pumps is a very economical method of providing a supply to meet the demands of a heavy flow for a prolonged fire. If the normal capacity of wells, low lift pumps and filters is considerably in excess of the maximum domestic consumption, the necessity for further increasing their capacity several fold may be offset by this storage.

2. The duplication of pumps and supply mains and the proper valving of suction and discharge headers is necessary to assure the reliability of the supply system. Careful arrangement of piping at the pumping station, the construction of the station and the installation of a second supply main to the closely built portion of the city are profitable insurance against the interruption of the supply at the time of a serious fire.

3. Four-inch mains are a detriment to a water system. Installation of this size of pipe is expensive, as large feeder mains must later be installed at frequent intervals to provide sufficient quantities for the protection of the city from disastrous fires.

4. Hydrants should be of sufficient size, frequently spaced and in proper condition. The failure of a hydrant adequately and instantaneously to perform its function defeats the principal purpose for which a water works is constructed and maintained.

The foregoing paper by Mr. Parsons was presented before the recent annual meeting of the Illinois Section of the American Water Works Association.

ECONOMICAL CONSTRUCTION AND MAINTENANCE OF GRAVEL ROADS

By John H. Mullen, Chief Engineer, Minnesota Highway Department, 1246 University Ave., St. Paul, Minn.

Gravel roads constitute by far the greater mileage of surfaced roads throughout the country, but gravel was not selected for surfacing this mileage due to economy of that type of road, but rather as the quickest and most satisfactory means of providing an all-weather surface.

Minnesota Experience

Our experience in Minnesota is probably typical of the general situation. In this State we have a State Trunk Highway System of 7,000 miles, of which 4,691 miles is gravel surfaced and 458 miles paved. The present highway officials are responsible for this ratio, for in the last four years we built 3,320 miles of gravel and 392 miles of pavement, but we are well aware of the fact that a considerable portion of the graveling is not the eco-

nomical type for the traffic to be served, although we have been obliged to use it on account of financial reasons, and the necessity of getting the traffic out of the mud.

In this connection I might be excused for repeating my conception of the true function of a highway department, namely: "That it is existing not merely as an engineering organization to lay out and supervise road and bridge work, but that it has the higher and more important duty of acting as a great transportation department, so to adjust the available funds and materials as to serve traffic most economically and provide uninterrupted transportation over the whole system."

When viewed in this light we cannot confine our consideration to the economic construction of each project on the system, when funds are limited, as they are in most states, but must also have in mind our responsibility for maintaining transportation in the best possible way over all the roads in our jurisdiction. So that the answer to the question, "When is a gravel road the economical type?" depends largely upon whether a state-wide system with a limited fund is under consideration or whether a certain definite project is to be decided upon where sufficient money is available or may be borrowed to build the ultimate economic type.

Some Minnesota Figures

Let us consider first a state-wide system and take the Minnesota figures as a basis. We placed 3,320 miles of gravel surfacing costing approximately $10,000,000, which carries an average daily traffic of 661 vehicles, at an average cost of $511 a mile per year for maintenance. The same original cost applied to pavement would have given us 400 miles which would have been maintained at a cost of $135 a mile, the remainder being earth road, costing $279 a mile per year for maintenance.

Disregarding the fact that without graveling we would have been unable to carry the traffic at all during bad weather on a part of the mileage, and confining ourselves to the figures, taking into account, as we must, the cost of transportation, and assuming the generally accepted difference in cost of transportation to be 2c. per vehicle mile between a concrete and gravel road and 3c. between a gravel and earth road, charging for obsolescence, betterment or replacement 10 per cent per year for gravel and 2½ per cent for pavement, we have the following annual cost.

By Graveling the Entire 3320 Miles

Fixed charge (replacement)	$1,000,000
Maintenance	1,696,520
Annual Highway Cost	2,696,520

The saving in transportation cost of 3c. per vehicle mile on gravel instead of earth roads at 661 vehicles 250 days, amounts to $16,458,900, making an annual net saving in highway transportation of $13,762,380 by a graveling program.

Using the same original fund for paving the 400 miles, leaving the remainder as earth road, would give the following charges and benefits:

Fixed charge (replacement)	$250,000
Maintenance 400 miles concrete	54,000
Maintenance 2,920 miles earth	814,680
Annual highway cost	$1,118,680

The saving in transportation cost of 5c. per vehicle mile on concrete instead of earth on 400 miles, with traffic concentrated to 1,000 vehicles per day for 300 days, amounts to $6,000,000, making an annual net saving to transportation of $4,881,320 if the fund were used for paving.

These figures indicate that either a graveling or a paving program would make a very substantial saving, but show that there is a $9,000,000 greater saving through using the funds to first get the traffic out of the mud by graveling a 3,300-mile system instead of concentrating on paving alone, and this does not take into account the greater satisfaction to the community by providing uninterrupted transportation, which cannot be measured in dollars.

When Paving Is Economical

The above calculation must not, however, be considered as an argument for graveling as against paving certain specific projects when that can be done without detriment to the whole scheme, or when the general system has been given a minor all-weather surface; for just as surely as day follows night, so must our main highways be finally paved in order to carry the traffic. The economy of paving certain projects instead of graveling them has been proven by various analyses, but it cannot be justified on the basis of maintenance cost alone. However, by introducing the factor of transportation expense as previously calculated and correcting our maintenance figures to correspond with the actual costs for lighter traffic we find that paving should be used

instead of gravel as an economic measure on an individual project when traffic exceeds about 400 vehicles per day, even though it may be necessary to issue bonds for that purpose. This calculated economic capacity of a gravel road is very nearly proved in actual surface conditions. We find that graveled roads carrying less than 500 vehicles per day can be maintained in a remarkably smooth condition and are perhaps the most satisfactory type from the viewpoint of the average road user, provided the traffic is not constant throughout protracted wet weather and does not include commercial bus or truck business, but when the traffic exceeds that figure, ceases to be seasonal, and moves regardless of weather, or when fast-moving passenger or express trucks use the road as a steady commercial proposition it is almost impossible to keep a gravel road in satisfactory condition at all times.

It seems needless to say that the same major principles of construction apply to the preparatory or foundation work of gravel as well as any other surfacing, but in this connection the importance of proper drainage will bear repetition, for the success of a gravel road, perhaps more than any other, depends upon a uniformly good subgrade. Then, too, the location, alignment and grade, the real permanent features of a road, should be studied with care, for the development of traffic will in time demand a better surface, and if a gravel road is properly built in all respects, the compacted roadbed thus formed is an ideal base for the subsequent pavement structure.

Methods of Gravel Surfacing

Gravel surfacing as practiced in the Middle West is rather different from the methods of gravel road building prescribed in the text books. Trenching and the placing and rolling in layers of different sized gravel has been found to entail needless expense and a system has been developed which is in reality a combination of construction and maintenance, and consists, briefly, of spreading gravel on the roadbed and compacting it under tranffic and maintenance. This sounds rather crude but it is the method whereby our State and some of our neighbors have been able to give almost immediate service and satisfaction and is a method which has been found to be the most economical after considerable experience in various systems of handling the work.

The Sub-Grade

As previously stated the sub-grade is our first consideration and when bad sand is encountered a sand clay crust is first built, or if the grade is composed of muskeag or unstable mucky material a covering of clay is applied to sustain the gravel wearing course. The sub-grade section for graveling is bladed to practically a flat section with never more than a 4-in. crown on a 30-ft. roadway.

Hauling is usually done with trucks, material being dumped in a windrow or ridge at the rate of 22 to 36 cu. yds. per station, depending upon the traffic to be served, the kind of gravel, and the material in the sub-grade. The gravel is then spread with blade graders leaving not to exceed 3 in. in thickness on a width of 20 ft., the remainder being left in a ridge on each side of that width. Blading is then continued and traffic turned onto the road, a small amount of gravel being gradually brought in and moved across the roadway until a crust is formed by the traffic. In this way the surfacing is compacted from the bottom up without at any time having enough material in the traveled way to produce a loose driving condition.

Selection of Material

Care is always used in the selection of material and we have gravel prospecting parties constantly employed to make detailed surveys of probable sources of supply. These investigations are based upon geological surveys and consist of test pitting to make certain of the quality and amount of material available. On account of the great variation in gravels found in different parts of the State we do not have a uniform specification for cementing values, wearing quality or grading of sizes, the only uniform requirement being that the maximum size of the gravel particles shall not exceed 1 in., which means that in practically all cases screening apparatus must be used. This is usually the ordinary rotary or shaker screen fed by a conveyor, but in the largest gravel hauling projects the material is generally loaded by a drag line or steam shovel through a "grizzly" or grate screen. To prevent oversize being hauled on the road it is required that the shaker or rotary screens have openings not more than 1 in. in size but when grizzly bars or grates are used it is required that the bars or grates be spaced not more than ¾ in. apart.

The State buys or leases the gravel pits,

preferably on an acreage basis but when impossible to secure acreage the gravel is paid for at so much per cubic yard as measured in the trucks delivered on the road. Contracts are not let on competitive bidding at a unit price for loading, screening and hauling to the first mile point and a unit price per yard mile for addition haul beyond the mile point. There is also a unit price bid for shaping and compacting at so much per hour for men and teams but generally this work is turned over to the State maintenance forces.

Winter Hauling

While most of our gravel hauling is done in the Summer time it has been found that a considerable saving can be effected by doing this hauling after the ground is frozen, especially when long hauls are involved, for that enables the contractor to use heavy truck equipment at a greatly reduced price per yard mile. When such hauling is done in Summer it is required that pneumatic tire equipment be used in order to protect the sub-grade from undue damage caused by heavy trucks with solid tires.

The success of gravel road surfacing is absolutely dependent upon proper maintenance and while we cannot say that there has been any great economy effected in the methods developed on this work there has been an effectiveness or efficiency developed through experience in handling a large mileage of this kind of road.

Maintenance Procedure

The maintenance as above stated, starts with the depositing of gravel on the sub-grade, and must be continuous. The two main methods employed for this purpose are the team patrol system and the truck and tractor method. When team patrolmen are employed the road is divided into sections of from four to seven miles each, dependent upon the amount of traffic over the road. The patrolmen work during the entire year except for a period of from one to three months during the Winter and are paid on an hourly basis for their work and the use of their teams with an additional allowance for a blade grader and such other heavy equipment which may be required, as it is found much better for the patrolman to own this equipment than for the State to furnish it.

Patrolled sections are marked off with sign boards at each end giving the name of the patrolman, which creates a feeling of responsibility and also serves to develop a sense of pride in the patrolman for his section of the highway. This patrolman is engaged almost continuously in blading the surface of the road except for such time as is required of him to haul repair material or to keep weeds cut and lines of drainage open, but it is also necessary to have additional equipment available in each maintenance district for the purpose of hauling surfacing material to stock-piles for the use of the patrolman in restoring the road surface.

Our experience has been that it requires not less than 100 cu. yds. of repair gravel per mile each year. This is hauled by state maintenance trucks and either spread on the roadway or placed in stock-piles at intervals of about half a mile from which the patrolman can haul with his team to make necessary repairs. The team patrol system however, is not suitable where extremely heavy traffic prevails or in isolated localities where such men are not obtainable locally. Under these conditions mechanical equipment is employed, consisting of combined tractor blade graders for the surface maintenance and trucks for hauling additional material. Under this system all the equipment is owned by the State, and mechanics are employed by the hour in the usual way.

Blanketing the Traveled Way

One very important point in gravel road maintenance is to keep a blanket of about half an inch of loose fine material spread over the traveled way. This material should be a selected screened gravel not more than half an inch in size and by continually moving it back and forth across the roadway with the maintenance equipment, the roughness of surface is avoided which is bound to occur if this film of material is not present.

Dust and Chatter-Bumps

There are two objectionable features to a gravel road, viz.: the dust nuisance, and rythmic corrugations, or what are commonly known as chatter-bumps. Both of these problems have occasioned considerable study and experimentation on the part of the road officials but it cannot be said that either has been satisfactorily solved. The dust nuisance may be relieved or eliminated either by the application of calcium chloride or oil. Calcium chloride gives quick and satisfactory relief particularly when the gravel is rather sandy or dirty, but is not so satisfactory when the road surface is composed of clean pebbly material. Ordinarily this treatment requires two applications dur-

ing the season, one of about 1½ lbs. per sq. yd. as soon as dry weather sets in and the next about ¾ lb. per sq. yd. within six weeks, and while serving as a dust preventive it also makes the maintenance much easier by keeping the road surface in a somewhat moist condition.

Oiling is not uniformly satisfactory and should not be attempted with a dirty or worn out surface but it has been found that an oiled gravel mat can be developed in the course of several years' treatment which presents a surface similar to a bituminous road surface but it requires constant care and is more than likely to develop an extremely rough condition under heavy traffic.

Removing Chatter-Bumps

Rythmic corrugations or chatter-bumps, presumably caused by the bounding impulses of the rear wheels of motor vehicles are started by any slight roughness of the surface; producing a washboard condition, the high spots remaining dry and hard and the depressions more susceptible to wear. This difficulty is encountered on all heavily traveled roads and can only be avoided by continuous blading or heavy planing carried on while the road is still in a smooth condition. When once these bumps develop it is necessary to scarify but the scarifying should only extend slightly below the depth of the depressions. Equipment has now been developed in the nature of a long wheel base blade grader having two or three rows of scarifier teeth set ahead of the blades which break up the surface to a depth of not more than half an inch. This equipment or a heavy steel planer of about 24 ft. in length and 10 ft. wide have been successful in avoiding or greatly reducing the washboard effect.

Calcium Chloride Successfully Used.

We are now maintaining very satisfactorily, with the equipment last described, several hundred miles of graveled road carrying an average traffic of from 1,000 to 1,500 vehicles per day. It has been necessary on the heavy traveled portions of this mileage to use calcium chloride to relieve the dust and this also has contributed largely to the successful maintenance. Intensive maintenance under such heavy traffic costs from $2,000 to $2,300 per mile annually and it must be said in fairness to the more permanent types of surfacing that there are times during the Spring and Fall and in rainy seasons that those same roads become very rough and are not at all suitable for the kind of traffic imposed upon them.

The Cure for Insufficient Funds

In conclusion it may be said that under light seasonal traffic, gravel is undoubtedly the most satisfactory and pleasing type of road surface but for heavier traveled highways it is at best a temporary expedient, uneconomical from the standpoint of the road user, but frequently the best solution of the road problem on an extensive road system which is being financed with insufficient funds to enable its administration in the most economical way. The latter condition can only be relieved when the road user, the motorist, comes to a realization of his cost of transportation and the great saving which might be effected in that cost by paying a small portion of it for a higher fee toward road improvement.

The foregoing paper by Mr. Mullen was presented at the 1923 meeting of the American Association of State Highway Officials.

PRESENT STATUS OF SHEET ASPHALT MIXTURE DESIGN

By M. F. Macnaughton, Chief Inspector, Milton Hersey Co., Ltd., Montreal, Quebec.

Truly economical sheet asphalt mixtures are not necessarily those which are low in first cost; but, in the broader sense of the word, are those which are low in annual cost. Such a definition implies a selection and proportioning of the mixture constituents in such a way that the resultant mixture will be that which will give the best and most lasting service at the least cost per unit of service.

Experience The Guide

We have a sufficient knowledge of the practical results obtained by certain selections and proportionings of the materials which go to make up an asphalt surface to enable us to build pavements, which, we are reasonably sure, will give satisfactory service. We can only do this, however, in the light of past experience, and not because of any very definite knowledge which we have of the fundamental principles underlying the design of these asphalt mixtures. We do know that certain mixtures, under certain traffic conditions, will prove satisfactory as pavement surfaces, but, generally, we do not know just why this should be, nor do we know whether or not these mixtures are the best that might be devised. Our whole knowledge of asphalt paving practice is contained in a collection of, generally, uncorrelated facts, obtained largely

from actual observations of the behavior of pavements in service over a term of years, and, very often, without any very definite information as to the conditions under which these pavements were constructed, or the intensity of service to which they have been subjected.

In this connection, it is interesting to note that, at a recent meeting in Chicago, at which were present representatives from many of the consulting paving laboratories throughout this country, and also representatives from the Asphalt Association, arrangements were planned for investigations to be carried on at the direction of a central committee of experts, with the object of correlating and enlarging present-day knowledge of the principles of sheet asphalt mixture design.

Basic Principles Not Fully Understood

It seems extraordinary that, though nearly 50 years have elapsed since the first synthetic sheet asphalt pavement in this country was laid on Pennsylvania Avenue in Washington, D. C., and though the industry has gradually increased in magnitude since that time, and very rapidly in the past few years, we should know so little today of the basic principles governing proper design of mixtures.

Twenty years ago, Mr. Clifford Richardson, the father of present asphalt paving practice, wrote "The Modarn Asphalt Pavement." It was then, and remains today, the most complete published discussion of the subject of asphalt paving; but though he described rather accurately the problems which must be solved before any exact definition could be made of the theory of sheet asphalt paving mixture design, he did not solve them. Instead, he suggested certain mixtures, which, from observation of the behavior of similar mixtures in service, he believed would prove to be satisfactory. His suggestion was adopted, his model mixtures were generally employed, and have been used since that day by the majority of paving men in all parts of this country.

Composition of Mixtures

Sheet asphalt surface mixtures are composed of sand, finely ground mineral filler and asphalt cement.

The sand is so graded as to reduce the percentage of voids, increase the density of the resultant mixture, and increase that quality known as the "inherent stability of the aggregate."

The added filler acts as an adjunctive towards the effectual realization of the above desiderata.

According to some investigators, the filler also acts as a stiffener to the asphalt cement, and they consider this effect as being distinct from, and beyond that brought about by the addition of a coarser mineral aggregate to asphalt cement. It is debatable whether the filler plays any part other than that of reducing the volume of voids and the size of the individual void, and so increasing the resistance to displacement of the mixture by permitting thinner films of bitumen.

Finally, the asphalt cement coats the surface of the particles, fills the voids, and unites the whole into a cohesive mass.

Amount of Bitumen Required

The amount of bitumen which a sheet asphalt mixture should carry, is, in the opinion of asphalt paving engineers, dependent on:

1. Certain characteristics peculiar to individual sands.

2. The surface area of particles to be characteristics of individual sands, such as condition of surface of the grains, or other peculiarities of physical property dependent upon their chemical constitution, affect to some extent the amount of bitumen which these mixtures will carry.

The surface area is claimed by many to be a regulating factor of considerable importance in determining the proper amount of bitumen for any mixture, though there is a wide divergency of opinion as to how great a factor this is.

Influence of Voids

Finally, nearly all engineers are agreed that the percentage of voids in the mineral aggregate bears some relation to the amount of bitumen which the mixture will hold; and that any marked excess of bitumen over the amount required to fill the voids will result in a decreased stability of the mixture, and an increased liability to displacement under traffic.

Early investigators of the relative influence of surface area and of voids in fixing the bitumen content of mixtures were of the opinion that the proper bitumen content was theoretically an indeterminate function of both. That opinion is held today by many, some giving greater value to the claims of the surface area theory, and others to those of the voids theory.

Recently, however, some investigators have expressed the opinion that, with normal mixtures, where the interstitial spaces are individually small, the percentage of voids is the governing factor, and

that the surface area exerts but a negligible influence on the amount of bitumen which the mixture will carry.

Recently, too, asphalt men have been waking up to a realization of the fact that conditions have changed during the last 20 years; and that perhaps the mixtures of 20 years ago, even if they were eminently suitable for traffic conditions at that time, are not the most suitable today. This feeling is widespread, and, as a result, we find today that mixtures are being laid of all characters and types, dependent only on the personal beliefs, and sometimes whims, of the engineer in charge.

Variation in Practice

Thus we find that in a great many cities, formulas recommended by Richardson for mixture design are still being followed; in St. Louis, a much coarser mixture is being laid, carrying from 30-40 per cent of sand aggregate coarser than the 40-mesh sieve, and with from 10-12 per cent of filler; in New York, the city specifications require a finer grading than that recommended by Richardson; in Chicago, a fine graded mixture is used, carrying from 18-20 per cent of filler; while in Montreal the present specifications require a comparatively large percentage of fine sand passing an 80-mesh screen, and a minimum of 20 per cent of filler, 80 per cent of which will pass the 200-mesh sieve.

This great variance in design results partly from varying conditions in different parts of the country, but mainly because of the lack of agreement between individual engineers as to the fundamental principles governing the design of asphalt mixtures.

Changes in Montreal Mixture

I do not know in every case the reasons for the adoption of these particular types, but I would like to trace the changes in, and development of, the Montreal mixture from what in 1916 was Richardson's heavy traffic grading to its present status.

In that year the Milton Hersey Company was given the task of organizing and carrying on an inspection service to control bituminous paving work in the City of Montreal. Mr. Charles A. Mullen was appointed supervisor of the work.

Up to that time the foremen in charge of the plants had practically complete control of the work, and mixtures were being laid without much attention being paid to their constituents. Sand was sand, a minimum of filler was desirable, as it reduced immediate costs, and just so long as the resultant surface mixture was black, and not too dry or too sloppy, it was laid.

The first work of the newly organized force was to change existing practice so as to produce a reasonably good surface mixture which would conform with general practice. Richardson's heavy traffic formula was chosen, and for the next 3 years the efforts of the department were confined to regulation of plant practice so as to secure a reasonable uniformity of the product.

Then they began to increase the percentage of fine sand in the aggregate. The object was not so much to reduce the total percentage of voids, as to reduce the size of individual voids, and so eliminate, as far as possible, the presence of large voids filled with asphalt, which, in their opinion constituted a source of weakness in the pavement. Then, four years ago as a means of attaining the same end, they began to increase the amount of filler in the mixtures, and continued this, until today, Montreal is laying pavements containing at least 20 per cent of filler, and a sand which gives a mixture, the composition of which is approximetely:

Passing Sieve	Held on Sieve	Per cent
10 mesh	40 mesh	20%
40 mesh	80 mesh	20%
80 mesh	200 mesh	30%
200 mesh		20%
Bitumen		10%
Total		100%

The immediate result of increasing the percentage of filler and the fineness of the sand grading was to reduce the amount of bitumen which the mixture would carry. This constituted a practical refutation of what had formerly been held to be one of the cardinal principles of sheet asphalt mixture design: namely, that the amount of bitumen which a mixture will carry increases with an increase in surface area, and that a well graded fine mixture with low voids will carry more bitumen than a coarser mixture with larger voids.

The resultant diminution in the amount of bitumen which the mixture will carry is quite appreciable, as evidenced by the fact that while Richardson's mixture would easily carry 12 per cent of bitumen with Montreal sands, the present Montreal mixture will carry, as a maximum, only 10.5 per cent.

This effect is not due to any conditions peculiar to Montreal sands, as it has invariably resulted wherever and whenever the fine grading with more than 16-17 per

cent of limestone filler has been substituted for the coarser grading.

At first we could not explain this apparent phenomenon, so Mr. Walter Adams who is C. A. Mullen's associate in the department, carried on a series of tests to see whether there was any rational explanation of this apparent discrepancy between theory and actual practice.

Briefly, he found that with the finer mixtures there was a decrease in the total volume of voids, and that the decrease in the amount of bitumen which the finer mixtures would carry agreed with and was proportional to the decrease in the total voids volume as determined by the cone test.

This would be satisfactory proof that the surface area, in these cases, did not influence greatly the bitumen content could we be sure that the percentage of voids as determined by the cone test was the percentage of voids existing in the pavement as laid.

The cone test method, however, is a purely arbitrary method of determining voids, and does not necessarily give the percentage of voids which exist in the actual pavement, nor even the minimum percentage of voids possible, though of all methods in general use it gives the lowest results.

From observation of the close agreement of the volume of voids, as determined by the cone test, with the volume of bitumen which the mixture will hold, it would appear that there is some ground for supposing that the volume of voids, as determined by the cone test, does happen purely by chance, to be a measure of the bitumen filled voids in the actual pavement.

Further investigation of this problem would require:

1. A means of determining the percentage of voids which would exist in the pavement as laid.

2. The measurement, by some necessarily arbitrary method, of the resistance to displacement of mixtures with varying percentages of bitumen, at temperatures within the range existent in actual service.

A number of methods have already been devised for determining this quality of asphalt mixtures, but none of them are capable of very satisfactory interpretation or of quantitative correlation.

Such an investigation is at present being carried on by the writer in the laboratory of the Department of Highway Engineering at the University of Michigan. This institution was selected because of the unique opportunities which it offers for the conduct of such work. It is hoped that this research will result in the compilation of some useful information relative to this phase of mixture design.

Conclusion

In conclusion, I would point out, that, though I have confined myself to the question of the relationship between bitumen content and the type of aggregate employed, a solution of this would be but a small part of the whole problem. Before we can bring the design of asphalt mixtures to the point where it may be termed a science, we must have definite information covering a number of points, which, today, are largely a matter of speculation; as, for example, the principles governing the relative merits of different sand gradings; what effect the absorptive power of different materials has on the characteristics of the resultant mix; and the results obtained by the use of different fillers, and the reasons therefor. These are but a few of the questions facing us, and the opinions held regarding them are many and varied. There exists in this field a tremendous opportunity for constructive, co-ordinated research in the solution of these problems.

The foregoing paper by Mr. Macnaughton was presented at the Tenth Annual Conference on Highway Engineering recently held at the University of Michigan at Ann Arbor, Mich.

PLANNING A MUNICIPAL PROGRAM

By P. F. Hopkins, City Manager of Engineering, Ames, Iowa

Villages grow to be towns, towns become cities of the second class, and some cities of the second class finally cross that imaginary line set by state legislatures and become cities of the first class, thereby falling heir to privileges and regulations which are not for the smaller communities. Usually this growth is gradual and undirected. Additions and subdivisions are added at the will of the promoter, with streets of varying widths and lots of indiscriminate sizes; utilities are extended without analyses of ultimate demands, and street grades usually become established to fit the natural lay of the ground. Topsy had nothing on the average city.

Then one day the city administration

wakes up to the fact that its utilities are overloaded, its principal streets congested and the demands for improvements come from civic organizations far beyond the ability of the city to finance. All the problems and aspirations of a real city seem to spring up at once to confront and confound the administration, which is still hampered by the shortcomings and finances of the country village.

It is easy enough then to see past mistakes and to say what should have been done; but it takes an unusual city council to see the proper remedies and find ways and means to accomplish them without creating dissension among the citizens and without placing a burden of debt on the city beyond its power to pay. That is the time when careful planning is imperative if worse mistakes are to be avoided. What have we? What do we need? How can we pay? That second question usually seems easy, but it can not be intelligently answered until the first is known, and cannot be attained until the third is solved.

These three questions are ever present —just like yesterday, today and tomorrow—never fully answered because they are constantly changing. Whenever they cease to be present, the city has ceased to grow; but in their place comes a still more distressing question—why? And if some council or citizen hits upon an answer and proves it, the first three questions immediately appear again, and so it goes.

What Have We?

At any given time, any city can answer this question if it has an organization which can separate each thread of the city's fabric from the snarl and study it both as a thread and as a part of that fabric. Water supply, sewers and sewage disposal, electric light and power, streets, drainage, sanitation, fire protection—all special problems, yet all necessary for proper development. Maps of the city and adjacent territory, of the water supply, sewer systems, both sanitary and storm, electrical distribution, population curves indicating probable growth, pumpage records, electrical output year to year —these are invaluable; and fortunate is the man who finds these records available when he begins his study of a city. If they are not available, then they must be obtained, because what actually exists must necessarily form the foundation for future building, and past requirements must furnish the basis for estimating future needs.

You will find that some section of the city is fairly well provided for as to water supply, sewers, etc., but beyond that section a development is under way which will eventually overtax these utilities unless some provision is made to take care of the increased demands. You will find block after block of water mains without line valves; intersections paved without water or sewer stubouts provided; 4-in. mains where 8-in. should be; a street which some day must serve as the outlet for considerable territory, dead-ended into a narrow, inadequate cross-street; three or four storm sewers converging into one so small that every shower overloads it. Every city has these conditions in some degree, and sooner or later they must be remedied.

It is in the correction of these conditions that a final plan is of great value. It insures to a great extent the economical expenditure of money, and the proper protection of the city's future growth. A change in the administration of a city need not affect the general scheme of development and all permanent improvements will be in the direction of a final end.

What Do We Need?

Having acquired a working knowledge of what exists, the next step is to outline, as best you can, what the probable future development will be. You will have to make many assumptions, some of which may be wrong, and the future may require many changes in your plans, but even a poor plan may be better than none.

From the census records and school attendance you can build up a fairly good population curve, and a little study will tell you the direction of future growth. With the amount and direction of growth determined, say for 20 years in the future, the development of the city's utilities can be outlined to meet this demand and sinking funds created to finance the improvements as they are needed. If the city's population is now 10,000, with every indication that it will be doubled in 20 years, it does not require much argument to convince you that water supply, electrical capacity and sewage treatment works which are now barely adequate, will be badly overloaded before that time. When possible, make your plans flexible, so that extensions may be made economically and in the logical order. Twenty

years hence the city may require 2,000,000 gallons of water per day, sewage disposal facilities for a like amount, and generating capacity for 2,000 kilowatts, but it would probably be poor business to provide for all of that now. The carrying charges on this excess capacity would make it mighty expensive by the time it was really needed. Keep ahead of the demand, but don't let the future put an unnecessary burden on the present.

Acquiring Sites

Park areas, playgrounds and school sites that are sure to be needed can be acquired at a fraction of what they would cost after improvements have been built on them. Sometimes the acquiring of a lot or two, before improved, will, at a nominal cost, insure the extension or widening of a street which will eventually be important. A zoning ordinance, with comprehensive explanatory maps and a campaign of education sufficient to get the citizens back of it, will insure rational building development and will protect real estate values from depreciating encroachments.

These are comparable to the things which the successful business man or corporation must do if the future is to be protected, and the city is not different. A little thought and study, a little planning, a little co-operation—it is astonishing how they help. When the season's work is finished, and the time comes for laying out the next year's work, then it is that you appreciate the help of well-laid plans.

To check up again and find how near the previous estimates or predictions meet the actual conditions, to make the necessary adjustments, to find the finances already provided, to feel that every move is in the right direction—these are the dividends on the previous investment in careful planning.

Winter Planning

The planning for the coming year's work must necessarily be done during the winter season. In general, the work will fall into two classes: that which is peculiar to the year, and that which is a part of a program extending over a period of years to a final development.

Under the first head will fall all maintenance and repair, grading, sidewalk work, sewer laterals, ordinary water mains, and, in most cases, paving.

It might seem that paving would be a part of a program extending indefinitely, but the average city does not have a definite paving program, and such work is usually inaugurated on short notice without it being a part of a plan. From any standpoint, however, a program for paving is desirable, as it allows ample time for the installation of underground work and ditch settlement before actual paving begins.

Under the second head will come extensions of main sewers and sewage disposal, water supply development, fire-fighting facilities, power plant extensions, etc. This second class work is usually easier to plan for, because the method of financing, preliminary work, etc., is already done, and if the general plan has been carefully worked out, it is simply a matter of completing the details.

The work which is peculiar to the year itself really calls for more detailed planning. As early as possible in the winter we go over the water distribution system, taking off quantities and sizes of pipe, specials, valves and hydrants on all streets where such extensions are needed, both to serve development and for fire protection. The different jobs are listed in the order of their importance, and the cost of each estimated. If the total exceeds the money available for the coming year, we simply throw out the least important until we can finance what is left. We at once call for bids on the material and place the orders. It so happens that in Ames we do not let contracts for laying water mains, doing all this work by force account. Practically the same method is followed in the electrical distribution, although in this work conditions are somewhat different from these in the water system. Materials can usually be obtained on short notice, and unless the market is attractive, there is no special reason for placing orders very far in advance of the time the material will be needed. However, the construction work is outlined and estimated.

In street grading, quantities are estimated, excess dirt allocated to near-by streets needing filling, or, if the dirt is not needed, provisions for wastage determined, and an estimate of cost made. As soon as the sidewalks to be constructed are known, an estimate of the grading cost is made and the order in which the work will be done scheduled. When spring opens up, the work is staked, grades figured, and from that point on the inspector directly in charge of the work takes full charge.

On all contract work which is assessed

against benefited property, it has been our policy to have the assessment plats ready, so that as soon as any section of the work is completed and the final cost determined, it is a short job to complete the final assessments. There is little gained by compelling a contractor to wait six months after his work is done before filing the schedules. In Ames we have consistently adhered to the policy of issuing special assessment certificates against benefited property, rather than the selling of bonds. There are arguments pro and con on this question, but once the certificates are delivered to the contractor, the city is through, while if bonds are issued the job drags through ten years, and the best the city can hope for is to come out even. Many of our smaller cities have had rather bitter experiences in issuing bonds and trying to collect the special assessments.

In this class of work we assess sidewalks against abutting property, sanitary sewers by drainage area, with graded benefits, and pavement by what we call the unit system.

Developments at Ames, Iowa

Three years ago the City of Ames took stock of itself and found that a steady growth in population had drawn on the reserve capacity of its utilities until none remained. The water supply was inadequate, building operations were being held up for lack of mains, the light plant was under capacity and distribution system in bad shape, and both utilities handicapped by lack of funds, sewage treatment plant improperly located and woefully inadequate, commercial garages and groceries were cropping up in the residence sections. A decided need for additional paving existed and all this in the face of a period of growth far greater than that of any previous period.

A systematic plan of development was outlined and adopted. Since that time 500 homes have been built in Ames and not one of these has been delayed because of the city's utilities. Five miles of water mains have been laid, 500 new water services installed, and 45 hydrants added—all financed from the earnings of the department. This year's plans include additional well and storage capacity, the start of an iron removal plant, and two miles more of mains. Much of the electrical distribution system has been rebuilt, 800 new meters added, plant overhauled and put on an efficient basis, new boilers installed and a new stack built sufficient for the final development of the plant. During these three years over $100,000 has been invested in these new additions alone from the earnings of the Department, and on Jan. 1, 1924, it had $23,000 cash on hand, no indebtedness of any kind, and a definite program of development that will take care of the growth of the city. Since the plant's electrical output doubles every 5½ years, it is evident that no considerable time can elapse without additions being made.

Two miles of sanitary sewers, a mile of storm sewers, new outfalls and a new sewage disposal plant have been built. This plant will take care of twice the present sewage flow, with provision for doubling that capacity.

One hundred and fifty thousand square yards of pavement and many miles of sidewalks have been laid.

A City Zoning and Planning Commission has practically completed its preliminary work, and 1924 will see a Zoning Ordinance in operation. Old ordinances are being revised to meet new conditions, new building and wiring codes are in preparation.

Had a definite plan for the city's utilities existed, much of this work would probably have been done previous to 1921, in which period it rightfully belonged, and this would have relieved the ensuing period of this added burden.

How Can We Pay?

The financing of public improvements is a big problem on which volumes have been written. I will, therefore, only comment briefly on this subject as applied to the smaller cities.

1. Specially assess all improvements when possible. It may not be the popular thing to do, and the bond issue often offers a tempting alternative, but bond issues, once started, will soon total the legal limit of indebtedness and may make impossible some other essential improvement which cannot be otherwise financed.

2. Keep the municipally owned utilities on a business basis. Establish the rates so that the earnings will finance extensions and replacements when needed and retire bond issues for expansion, which is properly chargeable to the future. Regardless of the financial condition of a utility, there should be a direct tax levy in proportion to the benefit accruing to all property. By this I mean that a water department should derive a portion of its income from a tax on all property to offset the investment in the

system for fire protection. The same is true of street lighting. It is not fair to the consumers to make them pay for the protection of the property of a non-resident who does not contribute to the support of the utilities through direct purchase of the commodities they sell.

3. Live within your income. Capitalizing the future is sometimes justified, but when this is done, provide for the retirement of the bonds when due. A serial bond is the safest in the end. A bond issue which falls due in a lump at the end of 20 or 30 years is seldom paid. The money is diverted to other purposes and refunding all or a portion of the issue is the result. Pay all bills when due and take advantage of all discounts; a city's credit is a sacred thing.

4. Be fair in your estimates and conservative in your promises. Many a worthy municipal project has fallen into ill-repute because it cost more than its advocates said it would, or because of extravagant promises which could not possibly be fulfilled.

In conclusion I will say that the affairs of a city are not materially different from those of other corporations. The taxpayers are the stockholders and the council the Board of Directors. The policies of the council should be a reflection of the wishes of the citizens, who receive their dividends in service. If the taxes paid are out of proportion to the services received it will probably be evidenced by a change in administration, but I have yet to find a fair-minded citizen who was not amenable to reason on any worthy project when all the facts were laid before him.

The foregoing paper by Mr. Hopkins was presented at the recent annual meeting of the Iowa Engineering Society.

RECOGNIZED TYPES AND SIZES OF VITRIFIED PAVING BRICK REDUCED FROM SIX TO FIVE

The Permanent Committee on Simplification of Varieties and Standards of Vitrified Paving Brick of the United States Department of Commerce held its regular annual meeting in Washington, D. C., March 28, 1924, and further reduced the recognized types and sizes of vitrified paving brick from six to five.

The first conference on paving brick simplification was held Nov. 15, 1921. At that time it was found that paving brick manufacturers throughout the country were making a total of 66 different types and sizes of vitrified brick for street and highway paving purposes and street railway track paving. Carefully considered eliminations at that and the three subsequent annual meetings of the committee

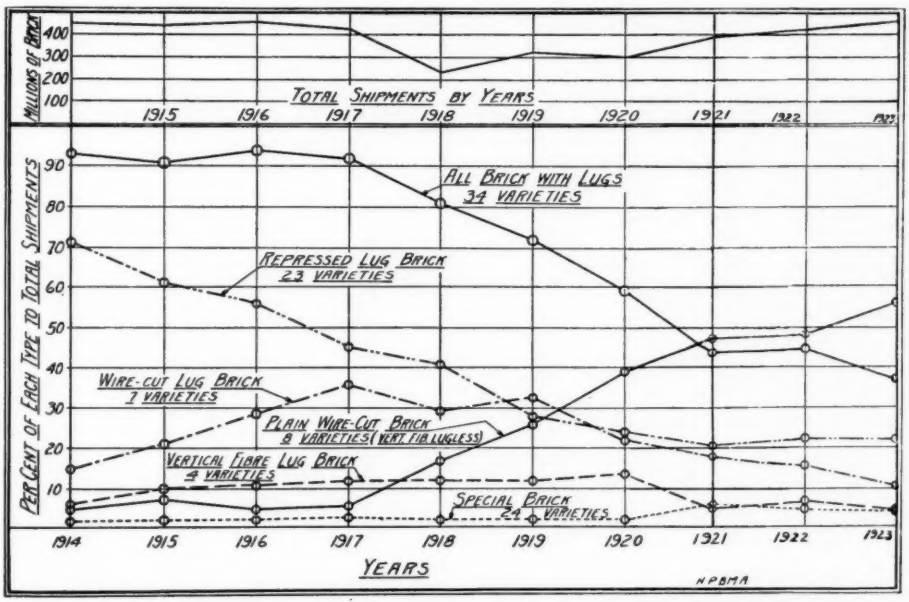

DIAGRAM SHOWING GROWTH IN PAVING BRICK INDUSTRY AND TREND OF VARIOUS TYPES OF PAVING BRICK.

have resulted in the establishment of only five types and sizes as officially recognized by the committee. The committee is composed of representatives of the foremost engineering organizations of the country as well as government bureaus and departments.

Recognized Types and Sizes

The recognized types and sizes as determined upon by the committee through a process of elimination over three years are as follows:

Plain wire cut brick (vertical fibre), depth, width, length, as customarily laid: 3x4x8½-in.; 3½x4x8½-in.

Repressed lug brick: 4x3½x8½-in.

Wire cut lug brick (Dunn): 3x3½x8½; in.; 4x3½x8½ in.

The one type and size eliminated by the committee at its last meeting was the 3½x3½x8½-in., wire cut lug (Dunn). This elimination, like all eliminations that have taken place since the work of simplification was taken up by the committee, was determined upon only after a survey of the industry's shipments revealed that it had steadily declined in favor among engineers of the country to a point where it constituted an exceedingly small percentage of the total shipments of the industry.

Guide to Elimination

For guidance at this and future meetings the committee adopted a resolution to the effect that "any variety of brick which shows less than 2½ per cent of total shipments for three consecutive years be eliminated and that any variety of brick which shows 5 or more per cent of the shipments for three successive years be reinstated in the list of recognized types and sizes unless special technical or other reasons show that such action is undesirable; provided, further, that the recognized types and sizes shall represent not less than 75 per cent of production."

It was following the passage of this guiding formula that the committee voted to eliminate the 3½x3½x8½-in. wire cut lug (Dunn) brick inasmuch as it constituted only nine-tenths of 1 per cent of the shipments for 1923.

As the list of recognized types and sizes stands at present there is only one type of brick not in the list that is manufactured generally, viz.: the "hillside" variety. This variety, used very largely in hilly sections of the country was put into the "special" class at the March 1923 meeting of the committee. It is therefore now being recognized, manufactured and sold as a "special."

The survey of the paving brick industry made in connection with the simplification conference reveals the fact that the industry has experienced a steady growth since the year of lowest production in 1918. Shipments for 1918, due to the effects of the war, dropped to 235,857,141. In 1921 shipments had increased to 392,412,943. In 1923 shipments had reached the high figure of 453,864,183.

PRODUCTION OF GAS FOR MUNICIPAL USE FROM FUEL OIL

By C. W. Arlitt, Municipal Securities, Littlefield Bldg., Austin, Texas.

Recently I learned of a method of gas production which is rather extensively used in California and other Pacific states, and feeling sure that this would be of some interest to the municipal corporations of Texas, I made a trip to San Francisco several months ago and personally examined this method of gas production.

There are now three methods of gas production, viz.: (1) Coal gas method, wherein bituminous coal is distilled in retorts; (2) illuminating water gas method, which provides for the passage of steam through an incandescent mixture of coke or anthracite coal, these fuels being, of course, placed in satisfactory gas producing generators; (3) finally there is the modern oil gas method of gas production in which crude oil or any of the by-products left after the distillates have been extracted are used as a basis of gas production in equipment which is especially designed to use such gas making materials.

The oil gas process equipment consists of steel cylinders on to which are fastened the various castings, valves, dampers, etc., these steel shells being lined with fire brick of first quality. There are two gas generators used, one a primary and one a secondary generator. Oil is burned under forced draft in the primary generator and the combustion is carried to a completion by passing the burning process into the secondary generator. This process is carried on until the generators are both hot, this stage of the gas production being commonly known as

the heating stage. Now we begin the gas making stage. When the valves and air inlets are closed and steam is introduced into the primary as well as the secondary generators, the steam combines with the carbon deposited on the heated brick lining of the generators, resulting in the formation of a gas which passes off into a washer and finally into a scrubber. Lampblack is produced simultaneously with the gas and passes off into lampblack filter tanks. This lampblack is immediately available for firing the boilers needed in the production of steam which is used as heretofore mentioned. In the oil gas process lampblack is produced at the rate of 12 lbs. per every 1,000 cu. ft. of gas produced, and this amount is just sufficient to fire the boilers. In the other methods of gas production there is always more than double the amount of lampblack produced, and as there is no great demand for lampblack, this by-product almost becomes a nuisance, while in the oil gas process the lampblack is not only desirable but quite necessary.

The oil gas process is not an experiment, nor is it unproven, as the process has been used for approximately 30 years. It is used in San Francisco, with a population of around three quarters of a million, and to this city we might add 40 more cities and towns in California of smaller population. Oregon, Nevada, Arizona and Hawaiian Islands are also using this process almost exclusively.

The cost of installing a gas plant of this kind for a municipal corporation will, of course, vary in accordance with local conditions, such as the compactness of the city or town, the character of soil conditions encountered, and also the amount of paving in existence at the time the gas pipe lines are installed. It may be roughly estimated that for a town of 5,000 inhabitants a gas plant complete could be put in for about $50,000, if all conditions are reasonable, then an installation for a town of 7,000 or 8,000 inhabitants might cost as much as $75,000 or $100,000, but the cost of large plants would not increase in direct proportion to population. The matter of actual cost could only be determined after a careful examination of each particular situation. A municipal gas plant, like a water, sewer or light and power plant, is to be considered as an asset, as it is in the revenue producing class.

By way of conclusion it might be well to notice that the cost of gas production under this improved oil gas process is considerably less than other methods of gas production now employed in this State. The last report on manufactured gas rates in several Texas cities is as follows:

	Pays	Population
Houston	$1.19	138,276
Austin	1.70	34,876
Beaumont	1.25	40,422
Brenham	2.20	5.066
El Paso	1.60	77,543
Galveston	1.45	44,255
Temple	1.65	11,033

All the above charges are being based upon 1,000 cu. ft. of gas.

San Francisco has a rate of $1.02 per 1,000 cu. ft., and with an increased consumption of gas the rates rapidly decrease from these figures. It will be well within the bounds of reason to say that 75c will be a safe figure at which to calculate the cost of producing 1,000 cu. ft. of gas in Texas, figuring oil at this time at 5c per gal. This cost of 75c not only includes labor, oil and fuel, but also a slight charge for water and maintenance.

The foregoing is from an address by Mr. Arlitt before the League of Texas Muncipalities.

EXPERIENCES IN SHOOTING WATER WELLS

By C. W. Varner, Well Contractor, Dubuque, Iowa.

In the shooting of wells to increase the amount of water they will produce the first consideration is the rock formation. The usual rock formations in Illinois and neighboring states are Trenton, Galena and Magnesia Limes, Shales, St. Peter and Pottsdam Sandstones. On account of the solid formation of limestones, any water coming from them must come from the seams or crevices in them.

Sandstone is very different in this respect. It is composed of a conglomeration of fine or coarse sand particles welded together by lime and silica particles and chemical action. Its water- producing qualities depend principally on the coarseness of these sand particles. Where these sand particles are very fine and have a deposit of clay running through them, they do not produce very much water.

The wells that it is most advisable to shoot are those of the St. Peter or Pottsdam sandstone. In the shooting of sand-

stone formation, the rock breaks into fine particles and in the case of a flowing well, usually flow out. If not, they can be bailed out with an ordinary bailer or sand pump. Limestone, on the contrary, breaks into such coarse material that there is danger of closing up the well entirely. Of course this material could be broken up with a set of drill tools but the hole would be in a shattered condition and likely to close up again. The benefits to be obtained in shooting a limestone well are not likely to be very great as the formation itself is so composed that it will not corrode up the same as sandstone.

According to my experience, corrosion is the main trouble that makes it necessary to shoot wells to increase their yield. In my estimation this corrosion is caused by chemical action from the chemicals that are in the water itself, such as sulphate of lime, bi-carbonate of iron and On account of the nature of the sandstone, it is very possible for these chemicals to form a coating similar to rust on the walls magnesia as well as some chloride of lime. of the well, closing off the pores from the sandstone itself and consequently stopping the flow of water. Where the sandstone contains considerable clay, it can be helped by shooting, that is, its water producing qualities can be increased, as it breaks the sandstone back some distance and creats more surface for the water to come through in much the same way as in the oil sands of oil wells.

I think that in the shooting of wells each well should be considered in a part by itself, as there are many things to take into consideration—the depth to the sandstone, the fineness of the sandstone, the thickness of the strata, and the amount of water or the amount of head of water over the strata to be shot. Fine, hard sandstone may be shot much harder than softer sandstone. If soft sandstone is shot too hard some trouble may be encountered with the pumps cutting out from the continual flow of this sand, sometimes for considerable time after the shot has been put in.

In cases where the well to be shot has a head of water over the sand stratum of ten to fifteen hundred or more, they may usually be shot with a larger charge than the wells where the amount of water over the strata is not so great, say, eight hundred feet or less. In the lesser depths dynamite may be used successfully. In the greater depths the explosive must be of a good quality, and usually special cartridges must be used in order to have any success. I think this one thing has caused more discouragement in the shooting of wells than any other one thing as the charges do not do good work under great depths of water unless great care has been taken in making up the cartridges, and in selecting the quality of explosives used, as a great quantity of explosive may not do any good if it is not used under good conditions.

Often in my experience in the shooting of wells in the last 15 years, I have learned many things that I found to be useful in this business. In several instances in the last seven years I have shot what formerly were flowing wells that had not flowed from 10 to 15 years. There were three wells for the City of Dubuque that I shot, one drilled in 1888, one in 1898, and one in 1900. The one drilled in 1888 and also the one drilled in 1898, had not flowed for several years. By shooting them the heads of these wells were brought back to 28 and 30-ft. above the surface, producing a flow of from 250 to 275 gals. per minute. One well shot for the Dubuque Packing Company in 1918 had not flowed for ten years or more. This was brought back to a normal flow of approximately 200 gals. per minute. In an artesian well for the Tri-State Milk Producing Company at Galena, Illinois, the flow was brought from practically nothing to approximately 250 gals. per minute. Part of this was due to a hole in the pipe, but the main increase in the amount of water was from the shooting of the sandstone. I have found that it is much better to shoot the sandstone in several places, from 40 to 50-ft. apart, depending on conditions as already mentioned such as the fineness and hardness and also the amount of clay in the sandstone.

The foregoing paper by Mr. Varner was presented at the recent annual meeting of the Illinois Society of Engineers.

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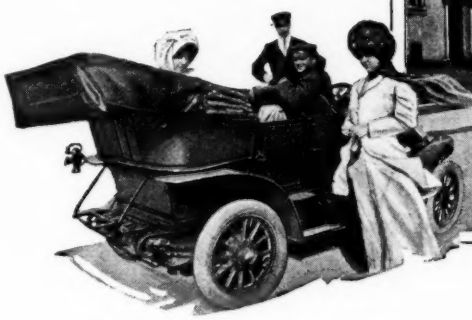

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